Volume 23, Number 4 February 28, 1969

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 6159, 6162, 6264, 6442, 6677, and 6691.

6051 (APDA–207) DETERMINATION OF IRON, NICKEL, AND CHROMIUM IN SODIUM BY ATOMIC ABSORPTION. Carmichael, H. T.; Meacham, S. A.; Kermoshchuk, J. O. (Atomic Power Development Associates, Inc., Detroit, Mich.). July 1968. 28p.

An analytical method for determining trace amounts of iron, nickel, and chromium in sodium metal is described. The method is based on separation of the sodium from the nonvolatile metallic impurities by vacuum distillation of the sodium at 400°C. The residue from the distillation is dissolved in hydrochloric acid and analyzed by atomic absorption spectrophotometry. A series of replicate sodium samples analyzed by this method had a standard deviation of ±0.1 ppM at a concentration level of 0.2 ppM for all three metals. Studies on synthetic residues showed recoveries of 90% or better on quantities of all three metals over the range of 10 to 40 μg. The method is capable of giving accurate and precise results over the range of 0.2 to 4 ppM of each metal, based on a sample weight of 10 g. (auth)

6052 (BARC–341) AN IMPROVED VOLUMETRIC METHOD FOR O/U ANALYSIS. Dharwadkar, S. R.; Chandrasekharaiah, M. S. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 9p. Dep.

A simple volumetric method for determination of O/U ratio was developed. UO_{2+x} samples were dissolved in acidified solution of ceric ammonium sulphate and the amount of Ce^{4+} utilized in conversion of U^{4+} to U^{6+} in solution was estimated by back titration with ferrous ammonium sulphate using Ferroin as an indicator. Overall acidity was adjusted to give about 3N at the end point. The precision in O/U obtained by this method is ±0.0032 and ±0.0038 near UO_2 and U_3O_8 end respectively. (auth)

6053 (BNL–13078) THE DETERMINATION OF OXYGEN CONCENTRATION AND MASS TRANSFER COEFFICIENTS IN SODIUM USING URANIUM. Isaacs, H. S. (Brookhaven National Lab., Upton, N. Y.). [nd]. 21p. Dep. CFSTI.

Experimental results and possible application of the use of uranium to determine oxygen concentrations in sodium are presented. Two electropolished uranium specimens were immersed in sodium for one-hour periods and weight gains were recorded. After additions of sodium oxide the weight gains increased in proportion to the amount of oxygen added. The oxygen concentrations were calculated by keeping an account of the weight of oxygen added to the sodium and removed by the uranium. Mass transfer coefficients of oxygen in sodium can also be determined by this method. (M.C.G.)

6054 (EURFNR–525) METHOD FOR CHEMICAL ANALYTICAL DETERMINATION OF PLUTONIUM AND URANIUM IN OXIDIC NUCLEAR FUELS. Lindner, L.; von Baeckmann, A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Translation of report KFK–701. 43p. (EUR–3714). Dep.

Work performed under United States–Euratom Fast Reactor Exchange Program.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 2176. (P.C.H.)

6055 ACTIVATION ANALYSIS DETERMINATION OF SOME TRACE ELEMENTS IN CRYSTALLIZED LEUKINAMINOPEPTIDASE FROM CATTLE EYE LENS AND IN THE LENS, AQUEOUS HUMOR, AND VITREOUS HUMOR OF CATTLE EYES. Boettger, M. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.); Fittkau, S.; Niese, S.; Hanson, H. Acta Biol. Med. Ger., 21: 143-9 (1968). (In German).

The lens, vitreous humor, and aqueous humor of cattle eyes were analyzed for zinc, manganese, copper, and cobalt by neutron activation and the results compared with literature values. (M.C.G.)

6056 FULLY AUTOMATED HIGH-PRECISION X-RAY DIFFRACTION. Baker, T. W.; George, J. D.; Bellamy, B. A.; Causer, R. (Atomic Energy Research Establishment, Harwell, Eng.). Advan. X-Ray Anal., 11: 359-75(1968).

From 16th Annual Conference on Applications of X-Ray Analysis, Denver, Colo. See CONF-670813.

X-ray diffraction angles are measured precisely, conveniently, and automatically by a specially designed instrument, the automatic precision x-ray goniometer connected on line to an Elliott 903B data processor. A monitor program controls two such instruments and two diffractometers simultaneously and allows a comprehensive set of experiments to be performed. The sensitivity is such that, when translated into terms of changes in the crystal-lattice parameter, a precision of 1 part in 10,000,000 is being attained, and indications are that absolute measurements are almost as good. The procedures, instrument, and atuomatic control are described, and the results of performance tests and some applications are given. (auth)

6057 THE APPLICATION OF RADIOISOTOPE NONDISPERSIVE X-RAY SPECTROMETRY TO THE ANALYSIS OF MOLYBDENUM. Langheinrich, A. P.; Forster, J. W. (Kennecott Copper Corp., Salt Lake City). Advan. X-Ray Anal., 11: 275-86(1968).

From 16th Annual Conference on Applications of X-Ray Analysis, Denver, Colo. See CONF-670813.

Radioisotope excitation, solid-state detection, and multichannel pulse-height analysis were applied successfully to the determination of molybdenum in copper and molybdenum-process intermediates. Analytical data are presented, and comparisons are made with the conventional x-ray fluorescence approach. The equipment performed satisfactorily in molybdenum plant control and shows promise for other industrial applications with the development of suitable isotope sources. (auth)

6058 NONDISPERSIVE X-RAY FLUORESCENT SPECTROMETER. Jones, W. Barclay; Carpenter, Robert A. (Technical Measurement Corp., San Mateo, Calif.). Advan. X-Ray Anal., 11: 214-29(1968).

From 16th Annual Conference on Applications of X-Ray Analysis, Denver, Colo. See CONF-670813.

Recent advances in semiconductor particle detector resolutions along with new electronic circuitry associated with these detectors make possible their application in nondispersive elemental analysis. The use of radioactive sources for exciting the characteristic x rays provides highly stable systems that can be used to accumulate data for prolonged periods. Due to the inherent stability of the detector and the excitation source, the only limitation in sensitivity is the ability to accumulate statistics above the background of scattered counts. Since this method of analysis is nondispersive, it has the capacity to determine many elements simultaneously. Solutions composed of mixtures of three or four elements were studied. The elements selected were bromine, rubidium, and

strontium. These elements exhibit wide variations in mass absorption coefficients for the various characteristic x rays emitted. The concentrations of the elements in solution varied from 10 ppM to 5% by weight. The relative intensities of the characteristic x-ray lines were compared with the concentration of the solutions to establish sensitivity curves and to study linearity of response as well. The interelemental interference was studied and the effect was evaluated for the particular elements under study. Means were developed for predicting and correcting for matrix effects. (auth)

6059 RARE EARTH ANALYSES BY X-RAY-EXCITED OPTICAL FLUORESCENCE. Burke, W. E.; Wood, D. L. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Advan. X-Ray Anal., 11: 204-13(1968).

From 16th Annual Conference on Applications of X-Ray Analysis, Denver, Colo. See CONF-670813.

X-ray excitation causes rare earth impurities in yttrium oxide and gadolinium oxide to emit intense and highly characteristic optical line fluorescence, which enables their analyses at low concentrations. The limits of detection for Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, and Yb in these two oxides range from 1 to 100 parts per billion (ppB). In other rare earth oxides which were investigated, the fluorescent intensities are greatly reduced. Successful analyses can be made only by dilution in high-purity Y_2O_3. This dilution raises the detection limits for rare earths in these other oxides to the part per million range. X-rays from the chromium target of a dual-target x-ray tube are about two times more efficient in exciting rare earth optical fluorescence than are the tungsten-target x rays even though the total energy output of the chromium target is only about one-third that of the tungsten target. With either target material, the rare earth intensities vary linearly with the x-ray tube current, but a plot of intensity versus the square of the accelerating potential is not linear; it drops off at a higher voltages. (auth)

6060 TOTAL NONDESTRUCTIVE ANALYSIS OF CAAS SYENITE. Volborth, A.; Fabbi, B. P.; Vincent, H. A. (Univ. of Nevada, Reno). Advan. X-Ray Anal., 11: 158-63(1968).

From 16th Annual Conference on Applications of X-Ray Analysis, Denver, Colo. See CONF-670813.

Determination of 35 trace and 8 major elements in a granitic rock by nondestructive x-ray emission and fast-neutron activation methods was accomplished. Trace elements arsenic, barium, cadmium, cerium, cobalt, chromium, cesium, copper, gallium, gadolinium, germanium, hafnium, mercury, indium, lanthanum, molybdenum, manganese, niobium, neodymium, nickel, rubidium, antimony, scandium, samarium, tin, strontium, tantalum, thorium, titanium, vanadium, yttrium, ytterbium, zinc, and zirconium and major elements aluminum, calcium, iron, potassium, and silicon were estimated in the vacuum X-ray spectrograph. Phosphorus was excited by a chromium-target tube. Major elements magnesium, sodium, and oxygen were estimated by the Henke aluminum-target X-ray spectrograph. Major elements oxygen and silicon were also determined by fast-neutron activation. Detection limits for traces are in our system in the range of 1 to 100 ppM with standard deviations of about 1 to 10 ppM. Precision in the determination of major constituents is better than 1% in relative standard deviation. The data are reported in parts per million for the trace elements and for the major elements as well. It is suggested that this type of reporting of geochemical data be preferred to the conventional reporting of major constituents as oxides. (auth)

6061 USE OF PRIMARY FILTERS IN X-RAY SPECTROGRAPHY: A NEW METHOD FOR TRACE ANALYSIS. Caticha-Ellis, S.; Ramos, Ariel; Saravia, Luis (Instituto de Fisica, Montevideo). Advan. X-Ray Anal., 11: 105-13(1968).

From 16th Annual Conference on Applications of X-Ray Analysis, Denver, Colo. See CONF-670813.

A method to improve the detectability of trace elements by x-ray fluorescent spectrography is described. The method consists of using appropriate filters in the primary, or exciting beam. The effects of using filters in the primary beam on the peak-to-background ratio R of a fluorescent line were analyzed on theoretical grounds. In fact, $R = [I_f(\lambda_\phi)/I_1(\lambda_\phi) + I_2 + I_f(\lambda_\phi)]$ where $I_f(\lambda_\phi)$ is the intensity of the analytic fluorescent line, $I_1(\lambda_\phi)$ is the background intensity due to coherent and Compton scattering of the primary radiation by the specimen, and I_2 is the background intensity due to scattering of the fluorescent radiation by the analyzing crystal. Analytical expressions were derived for $I_1(\lambda_\phi)$, I_2, and $I_f(\lambda_\phi)$, from which it was concluded: the ratio $I_1(\lambda_\phi)/I_f(\lambda_\phi)$ decreases when the filter used has its absorption edges at wavelengths longer than λ_ϕ, and the ratio $I_2/I_f(\lambda_\phi)$ can be separated into two parts which vary in opposite ways. It is then shown that the method should work well at short wavelengths and less well at longer wavelengths. The method was tested in the difficult case where overlapping of the analytical line with a characteristic line of the tube occurred, i.e., in the determination of traces of selenium by using tungsten radiation. The analytic line Se Kα has a wavelength of 1.106 Å, while W Ly_1 occurs at 1.098 Å. There is a marked effect of the filter thickness on the detectability; an optimum thickness appears to exist for each case. In the determination of selenium, the best filter thickness increased the detectability of selenium traces by an order of magnitude. Finally, from statistical considerations, the quantity $t\sigma^2$ is proposed as an index of the effectiveness of the filter: the smaller $t\sigma^2$ is, the better the filter is. Here σ is the standard deviation of the intensity of the analytic line and t is the total counting time spent on the measure of the analytic line and background. In order to study the dependence of the index $t\sigma^2$ on the filter thickness, measurements were made on samples of sugar containing known concentrations of strontium. Then $t\sigma^2$ was plotted against the thickness of the filter for each concentration; these curves do show a minimum. Thus, an optimum filter thickness exists in each case. (auth)

6062 THEORETICAL CORRECTION FOR COEXISTENT ELEMENTS IN FLUORESCENT X-RAY ANALYSIS OF ALLOY STEEL. Shiraiwa, Toshio; Fujino, Nobukatsu (Sumitomo Metal Industries, Amagasaki, Japan). Advan. X-Ray Anal., 11: 63-94 (1968).

From 16th Annual Conference on Applications of X-Ray Analysis, Denver, Colo. See CONF-670813.

With fluorescent x-ray analysis as routine work, the correction term for the coexistent element can be expressed as linear terms of the weight fraction of the element because the compositions of samples are limited to a small range. Usually those correction factors which require a great deal of work are obtained experimentally. Theoretical equations were obtained of fluorescent x-ray intensity which are in good agreement with experimental values. The linear correction factors are obtained from derivatives of those equations, and their values can be easily calculated with a computer. The experimental x-ray intensity versus the weight fractions is usually expressed as a line. However, the linear approximation is not correct over a wide range of the composition. The second derivative of the theoretical equation explains the deviation from the linear approximation and gives the range where the linear approximation is allowed. The calculations are applied to the analysis of stainless steels, several low-alloy steels, and iron ores, and experimental results are corrected by the calculated results. Correction factors for Ni Kα, Fe Kα, Cr Kα, Mn Kα, and Cu Kα in stainless steel and Cr Kα and Mn Kα in low-alloy steels are calculated for coexistent elements such as C, Si, Ti, Cr, Mn, Cu, Nb, and Mo. For example, standard deviations of Cr and Mn analyzed results in low-alloy steels decrease from 0.169 and 0.044% to 0.030 and 0.023%, respectively, with theoretical corrections. In the analysis of iron ore, the fluorescent x-ray intensity of Fe is affected by combined O, which is different for the various compounds of iron oxides, and other impurities such as alumina, silica, and lime. The correction factors of these are obtained by calculation, and the standard deviation decreases from 1.70 to 0.44% for 55.1 to 68.5% iron. It is found by experiment that the theoretical values have about 1 or 2% of relative errors, and their derivatives also have relative errors of the same order of magnitude. But the ranges of coexistent elements are usually small, a few percent at most in routine work, and the theoretical values can be used in practical analyses. (auth)

6063 X-RAY SPECTROGRAPHIC ANALYSIS OF TRACES IN METALS BY PRECONCENTRATION TECHNIQUES. Davis, C. M.; Burke, Keith E.; Yanak, M. M. (International Nickel Co., Inc., New York). Advan. X-Ray Anal., 11: 56-62(1968).

From 16th Annual Conference on Applications of X-Ray Analysis, Denver, Colo. See CONF-670813.

During the last two decades, x-ray spectrography has proven to be a very acceptable method of analysis because of the relative ease and rapidity of measurement of the intensity of characteristic wavelengths, the ready knowledge of the precision of the measurement, the facility of automating the analysis, and the nondestructive nature of the method. When chemical separation techniques are combined with x-ray spectrography, the problem of matrix effects is eliminated and the element being analyzed is substantially concentrated, which affords a means of performing trace element analyses. Published examples of preconcentration followed by x-ray measurement both outside and in the field of metallurgy are cited. (auth)

6064 X-RAY FLUORESCENCE SPECTROSCOPY IN THE ANALYSIS OF ORES, MINERALS, AND WATERS. Rose, Harry J. Jr.; Cuttitta, Frank (Geological Survey, Washington, D. C.). Advan. X-Ray Anal., 11: 23-39(1968).

From 16th Annual Conference on Applications of X-Ray Analysis, Denver, Colo. See CONF-670813.

X-ray fluorescence spectroscopy was used in solving a wide variety of geologic problems involving mineral, ore, and water

analysis. The technique was a powerful analytical tool in the survey of mineral deposits, as a control to monitor ore flotation processes, for the semimicroanalysis of mineral separates and of rare new mineral species, and for the determination of trace elements in lake and saline waters. Many preparation techniques were developed for the analysis of complex mineral systems, some combining x-ray fluorescence with other analytical techniques to provide a complete analysis. These, coupled with improvements in instrumentation, gave the x-ray analyst a means of extending analytical ranges to the microgram level and to include elements that were previously not detectable. Significant advances in sample preparation and methods development were made in the analysis of milligram quantities of complex geologic materials. The fusion and the solution of specimens appear to be the preferred methods of sample preparation. For samples that vary markedly in composition, the slope-ratio technique offers a new approach to solving matrix problems. (auth)

6065 ADVANCES IN X-RAY ANALYSIS. VOLUME 11. Proceedings of the Sixteenth Annual Conference on Applications of X-Ray Analysis held August 9–11, 1967. Newkirk, John B.; Mallett, Gavin R.; Pfeiffer, Heinz G. (eds.). New York, Plenum Press, 1968. 507p. (CONF-670813).

Separate abstracts were prepared for fifteen of the forty papers presented. One paper was abstracted previously and appeared as NSA: 21: 36343. (D.H.M.)

For abstracts of individual papers see: 6056–6064, 6099, 6100, 6264, 6670, 6692, and 6763.

6066 INTERNAL STANDARD ACTIVATION ANALYSIS OF SILICON IN STEEL. van Grieken, R.; Gijbels, R.; Speecke, A.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta, 43: 381-95(1968).

Nondestructive 14-MeV neutron activation analysis for silicon in steel has been applied with ^{56}Mn as internal standard. ^{56}Mn is formed from the iron matrix via the ^{56}Fe(n,p)^{56}Mn reaction. Several methods of internal standardization via ^{56}Mn are discussed. The 0.84-MeV photopeak of ^{56}Mn is recommended if steel samples of about the same composition are to be analyzed. Chemically analyzed steel samples are used as silicon standards. A precision of 0.7% was obtained for an analysis plus standardization time of 13 min. Special attention was given to interferences produced by concentration changes of impurity elements. Several possible sources of errors were investigated. (auth)

6067 DETERMINATION OF IMPURITIES IN TITANIUM AND TITANIUM DIOXIDE BY NEUTRON ACTIVATION ANALYSIS. I. SIMULTANEOUS DETERMINATION OF 16 TRACE ELEMENTS IN TITANIUM. Neirinckx, R.; Adams, F.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta, 43: 369-80(1968).

The most important metallic impurities in titanium which give long-lived isotopes on neutron irradiation can be determined by a rapid anion-exchange separation of Ti, Sc, Cr, Na, and Ag, after which the resin, containing most of the impurities, is counted on a high-resolution Ge(Li) γ spectrometer. Cu, W, As, Ga, Au, Sn, Fe, Zn, Co, Ta, Mo and Ni can be determined in one measurement, while Na, Cr, and Ag can be determined after an additional separation from the Sc isotopes, the major activities originating from titanium on neutron irradiation. Three different samples were analysed five times, and the reproducibility of the results was good. (auth)

6068 SIMULTANEOUS DETERMINATION OF RUBIDIUM AND CESIUM IN ROCK SAMPLES BY NEUTRON ACTIVATION ANALYSIS WITH A LITHIUM-DRIFTED GERMANIUM DETECTOR AFTER CHEMICAL GROUP-SEPARATION. Tomura, Kenji (Rikkyo Univ., Yoksuka, Japan); Higuchi, Hideo; Takahashi, Hiroshi; Onuma, Naoki; Hamaguchi, Hiroshi. Anal. Chim. Acta, 43: 523-6(1968).

A method is described for the simultaneous determination of Rb and Cs in rock samples with a Ge(Li) detector after a simple chemical group-separation based on tetraphenylborate precipitation. The combined method allows low sensitivities of 1 ppM for Rb and 0.005 ppM for Cs. The proposed method is applicable to the determination of the elements in geochemically important rocks such as basalt and diabase, but the detection of Rb in ultramafic rocks (PCC-1 and DTS-1) is difficult and ^{86}Rb may be best determined by β-counting after the mutual separation of Rb and Cs. (P.C.H.)

6069 MEANS AND METHOD FOR THE DETECTION OF URANIUM. Jungreis, Ervin; Ben-Dor, Lina (to Yissum Research Development Co.). U. S. Patent 3,403,004. Sept. 24, 1968. Priority date Nov. 29, 1963, Israel.

A reagent paper for the detection of U is prepared by immersing the paper in a mixture of p-dimethylaminoaniline hydrochloride and a concentrated alcoholic solution of salicylaldehyde, which is immersed in a boiling-water bath for a few minutes. The red solution on the filter paper is partially dried with cold air, and then the paper is placed on top of a beaker containing concentrated NH_4OH. The red color changes to yellow, and the paper is then completely dried and may be stored for a year. Hexavalent uranyl ions from solutions of pH 2 to 3 change the color of the paper to a red color whose intensity is proportional to the quantity of U present. The lower limit of U detection is ~ 1μg. (B.L.M.)

6070 THE EFFECT OF TEMPERATURE ON THE ELECTRICAL RESISTANCE OF PLUTONIUM DIOXIDE AND URANIUM–PLUTONIUM MIXED OXIDES. Berggren, Gunnar. Keram. Z., 20: 149-51(Mar. 1968). (In German).

Cylindrical pellets of about 6 mm in diameter, of plutonium dioxide or uranium–plutonium mixed oxides with plutonium contents of 2 to 25%, were tested by the end-contact method (two-point method) with an alternating current of 1000 Hz. The results are given as a curve of the function $\ln R = f(1/T)$, and wherever possible, the activation energy is calculated. Evaluation of the activation energies of PuO_2 between 200 and 500°C can be used for the determination of the proportion of oxygen. (auth)

6071 RESEARCHES ON MINERAL WATER RADIOISOTOPES IN THE CRISANA DISTRICT. Szabo, A.; Chereji, I. Stud. Cercet. Geol., Geofiz., Geogr., Ser. Geofiz., 5: 281-8(1967). (In Rumanian).

Radon, Ra, and U in old springs and relative recently drilled bore holes were determined. The results obtained are presented in a table showing the location, name of water source, depth, flow-rate, temperature, amount of elements per kg/water, total β and γ activity and basement rocks. The classification and description of the studied springs are also given. Hydrogeological and balneological considerations are made. (Rom. Sci. Abstr.)

6072 SYSTEMATIC ERRORS IN THE MEASUREMENT OF RADON DECAY PRODUCTS ACCORDING TO THE FILTER METHOD. Herrmann, D. B. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Naturwissenschaften, 55: 540(Nov. 1968). (In German).

For determination of the concentration of radon decay products in radon-containing atmospheres by enrichment on filters and analysis of decay curves, the two-filter method was used. (M.C.G.)

6073 RADIOACTIVE KRYPTONATES IN VOLUMETRIC ANALYSIS. PART 8. DETERMINATION OF THORIUM BY RADIOMETRIC PRECIPITATION TITRATION. Toelgyessy, J.; Siles, B.; Jesenak, V.; Varga, S. (Technische Hochschule, Bratislava). Isotopenpraxis, 4: 429-31(Nov. 1968). (In German).

A technique was developed for determining thorium by using sodium fluoride as the titrant and quartz glass kryptonate as the end-point indicator. When the end point is passed over, the surface of the quartz kryptonate is attacked by the hydrofluoric acid produced in the titration medium, and an adequate amount of ^{85}Kr is released. Consequently, the indicator activity decreases. Analysis data are treated by using a calibration curve. (auth)

6074 ION SOURCE FOR THE PRECISION RELATIVE MEASUREMENT OF THE ISOTOPIC COMPOSITION OF SOLID-STATE SAMPLES. Abashidze, I. V.; Kaviladze, M. Sh.; Melashvili, T. N.; Mirianashvili, G. M.; Saliya, Z. Isotopenpraxis, 4: 425-7(Nov. 1968). (In Russian).

An ion source for simultaneous analysis of three solid-phase samples is described. It allows measurements to be made to a relative accuracy of ±0.1%. A type of ion source using surface ionization permits the isotopic composition of the sample to be measured to an accuracy of ±0.04%. The construction of the ion source and the method of the isotopic analysis of Li, K, and Rb are described. (auth)

6075 DETERMINATION OF ULTRA-SMALL QUANTITIES OF VARIOUS ELEMENTS BY EVAPORATION OF RADIOACTIVE ISOTOPES FROM SOLID SURFACES. Troitskii, K. V. Radiokhimiya, 10: 598-600(1968). (In Russian).

A method of radioactive isotope evaporation from solid surfaces was used for determining ultra-small quantities of various elements. In experiments on the evaporation of ^{198}Au from quartz plate (20 mm in diameter) and porcelain crucible at 800°C the determination of gold content up to 1 to 10^{-4} γ in specimens was achieved. The method proved effective for determining microquantities of Ca, Cd, Co, Sn, and Tl using respective carrier-free radioisotopes: ^{90}Sr, ^{137}Cs, ^{95}Zr, ^{95}Nb, ^{144}Ce, ^{90}Y, $^{103-106}$Ru and ^{140}La. It is important to have three calibrated graphs: one for determining concentrations from 1 to 10^{-4}; the other from 10^{-4} to 10^{-6}; and the third from 10^{-6} to 10^{-9} γ mc. (R.V.J.)

6076 DETERMINATION OF MICROIMPURITIES IN INDIUM ARSENIDES BY NEUTRON ACTIVATION. Vasil'ev, I. Ya.; Razumova, G. N.; Shubo, I. D. Radiokhimiya, 10: 596-8(1968). (In Russian).

A neutron activation method is described for determining microimpurities of Au, Se, Te, Ge, Sb, Cu, Zn, and Cd in a 0.5 to 0.1 g of indium arsenide. The sensitivity of analysis of 1.2×10^{12} neutrons/cm^2 sec irradiated specimens was 5×10^{-9}% for Au, 3×10^{-7}% for Cu, Sb, and Ge, 5×10^{-6}% for Zn and Te, and 5×10^{-5}% for Cd and Se. (R.V.J.)

6077 STRONTIUM ISOTOPIC COMPOSITIONS OF GANGUE MINERALS FROM HYDROTHERMAL VEIN DEPOSITS. Reesman, R. H. (Massachusetts Inst. of Tech, Cambridge). Econ. Geol., 63: 731-6(Nov. 1968).

Strontium isotopic analyses were made on strontium-rich, rubidium-poor, gangue minerals from several vein-type hydrothermal mineral deposits. These minerals were from deposits in which: tertiary mineralization occurs within rocks of tertiary age, tertiary mineralization occurs within rocks of Precambrian age, and the mineralization is Precambrian. The results of these analyses show that the gangue strontium was derived, at least to a very large extent, from the rocks of the host environment. (auth)

6078 ANALYTICAL APPLICATIONS OF TERNARY COMPLEXES. VII. ELUCIDATION OF MODE OF FORMATION OF SENSITIZED METAL–CHELATE SYSTEMS AND DETERMINATION OF MOLYBDENUM AND ANTIMONY. Bailey, B. W.; Chester, J. E.; Dagnall, R. M.; West, T. S. (Imperial Coll. of Science and Tech., London). Talanta, 15: 1359-69(Dec. 1968).

The ternary complexes that are formed when surface-active agents are added to various metal–dyestuff chelate systems were shown to be dependent on the formation of micelles. Spectrophotometric measurements indicated that true ternary complexes are formed with well defined structures, and that the changes in absorption spectra produced are not due to simple adsorption of the binary metal-dye complex on to micellar aggregates. Some suggestions are made to account for the nature of the observed changes. The analytical potentialities of this type of system are illustrated by the formation of such complexes between Mo or Sb, Catechol Violet and cetyltrimethylammonium bromide, yielding molar absorptivities of 4.6×10^4 and 3.0×10^4, respectively. (auth) (UK)

6079 THE ABSOLUTE ABUNDANCE OF THE TITANIUM ISOTOPES IN NATURE. Belsheim, Harold Arthur. Contract W-7405-eng-82. Ames, Iowa, Iowa State Univ., 1968. 93p. (IS-T-217).

Thesis.

Abundances in 20 Ti ores and minerals of worldwide occurrence and in the TiO_2 used in the chemical determination of the atomic weight of Ti were compared with the abundances in a reference sample of TiO_2. No variations were found. The mass spectrometer was calibrated by analyzing mixtures of separated Ti isotopes. From the calibration were obtained the absolute abundances in the reference sample, and thereby also the absolute abundances in nature. (Disser. Abstr.)

6080 SEPARATION OF RHENIUM(VII), TUNGSTEN(VI) AND MOLYBDENUM(VI) BY THIN LAYER CHROMATOGRAPHY. Shiobara, Yai (Tokyo Univ. of Education). Bunseki Kagaku, 17: 1396-1400(Nov. 1968). (In Japanese).

Separation of Re(VII), W(VI) and Mo(VI) can be effected chromatographically on a silica gel-coated polyester film. A sample solution is applied on Eastman Chromagram Silica Gel Sheet 6060, 100 μ thick, and developed by the ascending technique using a solution of either acid or salt as the developing solvent. Among the solvents studied 1.0 to 1.8N HCl is found to give the most favorable resolution of the three elements, yielding discrete spots with the least tailing. Development with 1.0N HCNS, 1.0 to 1.8N malonic or acetic acid also affords a good separation of Re and W/or Mo. NH_4CNS solution 1.0 to 1.8N is suited to resolve Mo and W as well as Re and W. In all the solvent systems studied R_f values are in the order Re > Mo ≥ W. The methods described can successfully be applied to the detection of Re in Re–W alloys. (NSA of Japan)

6081 DETERMINATION OF OXYGEN IN METALLIC BERYLLIUM BY VACUUM FUSION METHOD. Sudo, Emiko (National Research Inst. for Metals, Tokyo); Hashimoto, Akira. Bunseki Kagaku, 17: 1369-73(Nov. 1968). (In Japanese).

Determination of oxygen (0.004 to 1.2%) in metallic Be by the vacuum fusion method was studied. Comparison of various bath methods indicated that Pt bath, Pt–Sn bath, Cu bath and Ni–Sn bath gave inaccurate results with incomplete extraction. By C (chip)–Sn–Ni foil method whereby samples were thrown in a crucible at 1300°C and the temperature raised stepwise to 1450, 1650, and 1750°C, the extraction of gas was made much higher, and the results of determination were in good agreement with those by fast neutron activation method and iodine-methanol method. The coefficient of variation was about 10%. (NSA of Japan)

6082 RESEARCH ON THE X-RAY LUMINESCENCE METHOD. I. A CONVENIENT X-RAY LUMINESCENCE SPECTROMETER AND ITS APPLICATION TO ANALYSIS OF RARE EARTHS IN YTTRIUM OXIDE. Sasaki, Naohisa (Mitsui Mining and Smelting Co., Ltd., Japan). Bunseki Kagaku, 17: 1387-95(Nov. 1968). (In Japanese).

An x-ray luminescence spectrometer was developed for measuring the x-ray-excited emission spectra. The apparatus is assembled with x-ray excitation units of an x-ray spectrometer (Rigaku Denki Model K-3 with Machlett OEG-50 tube W target) and a spectrophotometer (Hitachi Model 139 with QPD-53 recorder). A single convex lens (f = 35 mm) is used at the connection part. The x-ray source gives no interference with emission spectra, because x rays are not reflected, and hence the apparatus can be easily assembled. Discoloration of lens due to x-ray radiation has not appeared even after a year. Emission intensity and sensitivity as functions of x-ray tube and spectrophotometer conditions are studied. Rare earths in Y_2O_3 are determined with sensitive results. (NSA of Japan)

6083 DETERMINATION OF TANTALUM BY X-RAY FLUORESCENCE ANALYSIS IN TREATED TIN SLAG. Hisano, Kingo; Oyama, Kiyoshi (Ishihara Sangyo Co., Ltd., Japan). Bunseki Kagaku, 17: 1373-7(Nov. 1968). (In Japanese).

X-ray fluorescence analysis with borax fusion was applied to the determination of Ta in treated Sn slag. For rapid analysis, the fused borax bead was employed without crushing. Sodium fluoride was added to melt the samples clearly, and Na_2SO_4 was added to prevent the borax bead from cracking. Lanthanum oxide was added to eliminate the effects of diverse elements. The measuring time was shortened by this method. (NSA of Japan)

6084 GAMMA-SPECTROSCOPIC DETERMINATION OF THE ISOTOPIC RATIOS ^{235}U TO ^{238}U. Ishimori, Tomitaro; Ueno, Kaoru (Japan Atomic Energy Research Inst., Tokyo). Bunseki Kagaku, 17: 1439-41(Nov. 1968). (In Japanese).

The method for determining the ^{235}U content in U by comparing the γ activities from ^{235}U, from ^{234}Th, and from ^{234m},^{234}Pa formed by disintegration of ^{238}U was extended to U samples in which equilibria are not yet attained. The method is suitable for determination of 0.4 to 1% ^{235}U at about 20 days after separation of U from Th. Values obtained agree well with those obtained by mass spectrometry. (NSA of Japan)

6085 STUDIES ON THE SULFUR-CONTAINING CHELATING AGENTS. 19. RADIOISOTOPE DILUTION METHOD FOR DETERMINATION OF INORGANIC AND ORGANIC MERCURY BY PAPER CHROMATOGRAPHY. Tanaka, Hisashi; Sugiura, Yukio (Kyoto Univ.). Bunseki Kagaku, 17: 1424-7(Nov. 1968). (In Japanese).

A new radioisotope dilution method was developed for determination of trace amounts of $HgCl_2$ and phenylmercuric chloride. Penicillamine was used as the chelating agent, and paper chromatography was applied for the separation. A known amount of radioactive mercury (^{203}Hg) and a substoichiometric amount of penicillamine are added to the sample solution, and the resulted solution is chromatographed on filter paper using the mixture of isopropyl alcohol–concentrated NH_4OH–water (7 : 1 : 2) as the developer. Standard solutions containing radioisotope are treated in exactly the same manner. The separation of the chelate and unreacting Hg compound was satisfactory. The amount of mercury was calculated from measurements of the radioactivity of the spot of the chelate and the standard solution. Determination of the amount down to 10^{-4} g could be possible, 10^{-3}M penicillamine and 10^{-5}M of mercuric chloride-^{203}Hg or 10^{-5}M of phenylmercuric chloride-^{203}Hg being used within the range of pH value 6 to 10. The influence of Ni, Fe, Cu, Zn, and Co was not serious. (NSA of Japan)

6086 CHOICE OF CONDITIONS FOR THE NEUTRON-ACTIVATION DETERMINATION OF MANGANESE IN A TWO-COMPONENT MIXTURE. Boreisha, E. G.; Kravtsov, V. V.; Sokolov, L. S. Visn. Kiiv. Univ., Ser. Fiz., Khim., 7: 57-61 (1967). (In Ukrainian).

Optimum conditions were investigated for determination of Mn in a Mn ore agglomerate by using a neutron generator (10^8 n/sec). With a recording time of 10 min and a sample of 100 to 1000 ml, the method can be used to determine 25 to 50% of Mn with a statistical error of 0.5%. (Anal. Abstr.)

6087 APPLICATIONS OF RADIOISOTOPES IN POLAROGRAPHY. Mattes, Frederick Henry. Bloomington, Ind., Indiana Univ., 1968. 132p.

Thesis.

An electrode process in which a metal ion is reduced to an amalgam at the dropping Hg electrode can be detected by mea-

surement of the radioactivity in the Hg drops if a radioisotope of that metal ion is present in the electrolyte solution. The sensitivity and specificity of the counting procedure allows such electrode processes to be detected at very low concentrations and in the presence of gross interferences. A cell was designed and tested that utilized a bubble of N_2 suspended in a narrow tube to separate the radioactive test solution from the wash solution below. Drops of Hg from the electrode fell through the nitrogen bubble into the decontaminating wash solution and were then removed individually into planchets. Air-saturated water served to remove the activity from the Hg. After evaporation of the water, the planchets were counted and the data used to prepare plots of observed activity vs applied voltage. At concentrations above 10^{-5}M total Tl ion, the activity-voltage curves and the current-voltage curves (recorded simultaneously) gave half-wave potentials and slopes in good agreement. Recovery of the radioactivity was 80% or better, based on calculations using Faraday's law, drop time, % ^{204}Tl in the solution and the counting efficiency of the radiation detection unit. For solutions below 10^{-5}M total Tl, an almost linear increase in activity was observed in the diffusion-limited region and was attributed to the faradaic discharge of the electrical double layer at the surface of the Hg drop as the drop fell through the active text solution. Addition of another more easily reducible ion to the solution decreased the rise in activity. A comparison of the experimentally measured increase in activity with that calculated for a model based on the complete discharge of the electrical double layer at the surface of the mercury drop gave generally poor agreement, probably because of the presence of traces of oxygen and other reducible impurities present in the solutions. Two anomalies were observed in the diffusion region of the activity-voltage curves. The first and most apparent was a relatively large and sudden increase in activity at about −0.9 V vs the S.C.E. A distinct, though very small, ripple in the current-voltage curve was also noted in the same region. The second anomaly was the apparent limiting and in some cases decreasing activity at potentials more negative than −1.1 V. This behavior can be explained in terms of a change in drop time with applied voltage and also in terms of the irreducible reduction of hydrogen ion at about −1.1 V, which can discharge the double layer of the Hg drop. The radiopolarographic technique was used to follow one component of a "mixed-current" electrode process in which the net observable current is the resultant of two or more component currents. The reduction of Tl(I) in the presence of CN^- was studied using ^{204}Tl as tracer. At cyanide concentrations below 10^{-3}M, both the conventional and radiopolarographic waves are normal. At higher CN^- concentrations at which "mixed" anodic and cathodic currents are observed, the radiopolarographic waves are displaced upward, although the half-wave potentials for the reduction of Tl remain constant with increasing CN^- concentration. This is in contrast to the current-voltage waves for Tl, which exhibit an apparent negative shift in the half-wave potential with increasing cyanide ion concentration because of the onset of the anodic oxidation of Hg. The upward displacement of the radiopolarographic waves increased with increasing CN^- concentration and is a result of a spontaneous reaction occurring between the Hg of the drop and the Tl ion in the solution after the drop is detached from the electrode. Brief, exploratory studies were carried out with ^{110m}Ag, ^{63}Ni, and ^{65}Zn. (Disser. Abstr.)

6088 STUDIES ON THE MOLYBDENUM(VI)–KOJIC ACID COMPLEX. Rao, V. Pandu Ranga; Rao, K. Venugopala (Andhra Univ., Waltair, India). Curr. Sci. (India), 37: 696(Dec. 20, 1968).

Kojic acid gives a yellow complex with molybdenum in aqueous solutions, but in view of low molar absorptivities it cannot be used for determination of molybdenum. (M.C.G.)

6089 DIFFERENTIAL POLAROGRAPHIC STUDY ON RADIOPROTECTIVE SUBSTANCES CONTAINING SULFHYDRYL. Ueno, Y. (Kyoto Univ.). Experientia, 24: 970(Sept. 15, 1968).

The radioprotective compounds were studied by differential polarography in an acetate buffer at pH 5.2. The chemicals studied were L-cysteine, reduced and oxidized glutathiones, cysteamine hydrochloride, cystamine dihydrochloride, S-β-aminoethylisothiuronium bromide hydrobromide (AGT), and bovine serum albumin. (M.C.G.)

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Refer also to abstracts 6148, 6161, 6188, 6190, 6200, 6680, and 7213.

6090 (KFK-765) COMPLEX FORMATION OF FIVE- AND SIX-VALENT ACTINIDE ELEMENTS WITH α-HYDROXY CARBONIC ACIDS. Schaefer, J. B. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). June 1968. 61p. Dep. (In German).

The complex reaction of pentavalent Np and hexavalent U and Pu with acetic acid and α-hydroxycarboxylic acids (glycolic acid, lactic acid, α-hydroxybutyric acid, α-hydroxyvaleric acid, and α-hydroxycaproic acid) was investigated by spectrophotometric and potentiometric methods. The applicability of the spectrophotometric method was limited by the resolution of the spectrophotometer and the autoradiolysis and hydrolysis of the metal ions. The intensive absorption bands of Np(V) and Pu(VI), which for the free hydrated cations lie at 9804 and 8306 Å, are displaced in the complex compounds up to 100 Å toward the higher wave lengths. The concentration both of the free cations and the complex compound can be calculated from the pertinent absorption spectrum. The combination of both measurement data leads to the stability constants for the complex. With the help of electronic data processing, the application of this method was extended because of time economy and greater accuracy. For the quantitative measurement of the 8306 Å extinction of the Pu(VI), a split width of 0.15 ± 0.01 mm is necessary so that the error of the concentration determination is ±2%. With acetic acid both U(VI) and Pu(VI) complexes are formed with a maximum of three ligand anions per metal ion. α-Hydroxycarboxylic acids give only the 1 : 1 and 1 : 2 complexes, whose stability constants are about 30% greater than that of the acetate complexes. A chelate-type formation with participation of the hydroxyl group is therefore assumed. Pentavalent Np gives, corresponding to a positive charge of the NpO_2^+ ion, only the 1 : 1 complex. The hydrolysis reaction of Pu(VI) and Np(V) can be followed spectrophotometrically as the complex formation reaction. In both cases the first reaction step consists in the addition of an OH^- ion, then the Pu(V) hydrolysis proceeds more simply than that in the first stage of the polynuclear U(VI) hydrolysis. The spectral photometric method can probably be generally applied to the clarification of complex equilibria, since in all previously known cases (hydroxides, carboxylic acids, hydroxycarboxyl acids, pyridinecarboxylic acids, and β-diketones) there is a displacement of the principal absorption line. The stability constants of the complexes studied were determined at 25.0°C, and the results are tabulated. (tr-auth)

6091 (MLM–1563) ^{210}Po ISOTOPIC FUEL FORM DATA SHEETS. Abrahamson, S. G.; Matson, L. K.; Strickland, W. E. (comps.). (Mound Lab., Miamisburg, Ohio). Oct. 31, 1968. Contract AT(33-1)-Gen-53. 33p. Dep. CFSTI.

Collected data on isotopic fuel forms of ^{210}Po are presented. Chemical and physical properties of polonium metal, gadolinium polonide, and gadolinium polonide in a tantalum matrix are included. Since some properties have not been determined for ^{210}Po, data from elements in the same family as Po, e.g., S, Se, or Te, and from compounds analogous to the Po compounds are given wherever it can be assumed that these properties are similar to those of the desired Po fuel form. Properties of lead are included when pertinent. (J.G.B.)

6092 (NP–17661) STUDY OF URANOUS NITRATE AS A REDUCER OF PLUTONIUM. IV. REDUCTION OF Pu IN SOLUTION BY U(IV). Lopez-Menchero, E.; Salomon, L.; Bardone, G.; Lopez de Manterola, J. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Mar. 1966. 59p. (ETR–184). Dep.

The reduction of Pu(IV) by U(IV) was studied in hydrazine-stabilized aqueous phase, in organic phase, and in emulsion. The case where Pu is found on the scale of g/l and the case where Pu is present in the trace state were considered. For each case, the stoichiometry, the kinetics, and the effects of temperature, acidity, and atmosphere were determined. Rate constants were determined in the presence of air and in nitrogen atmosphere. The reoxidation of Pu(III) in solution was also studied under different conditions. (tr-auth)

6093 (NP–17690) NEUTRON INELASTIC SCATTERING STUDIES OF WATER AND IONIC SOLUTIONS. Research and Development Progress Report No. 372. Safford, G. J.; Leung, P. S.; Schaffer, P. C. (Union Carbide Corp., Tuxedo, N. Y. [Nuclear Div.]). Aug. 1968. Contract 14-01-0001-372. 92p. GPO.

The intermolecular frequencies between 900 and 8 cm^{-1} of H_2O molecules in water and aqueous solutions of $LaCl_3$, $CaCl_2$, $MgCl_2$, CsI, CsCl, KSCN, KI, KBr, KCl, KF, NaCl, $LiNO_3$, and LiCl have been measured by slow neutron inelastic scattering. In addition, the diffusive kinetics of H_2O molecules in aqueous solutions of $LaCl_3$, $MgCl_2$, CsCl, KSCN, KCl, KF, NaCl, and LiCl have been investigated and compared to water. The dependence of observed spectral changes on temperature, concentration, and ionic size and charge was studied. Simultaneous changes were observed for

both the intermolecular frequencies and the diffusive motions of H_2O in ionic solutions relative to pure water and were specific to the ions present, their concentrations, and the temperature. They result from the modification of water structure and the formation of hydrated complexes by ions. For solutions of salts having a small and/or highly charged ion (i.e., $LaCl_3$, $MgCl_2$, LiCl, and KF) new maxima appear at frequencies similar to those of the rocking, wagging, and twisting vibrational modes and to the ion-water stretching frequencies of H_2O molecules in the corresponding solid salt hydrates. They intensify with increasing concentration. While increasing temperature with these frequencies broaden they persist to 75°C. At lower temperatures (1 and 25°C) where the diffusive motions are in accord with a delayed diffusion model, these salts cause a corresponding decrease in the self-diffusion coefficients, D, and increase in the residence times, τ_0, relative to pure water. D increases and τ_0 decreases with increasing temperature, but remain respectively smaller and larger than for pure water. However, at higher temperatures the diffusive kinetics depart from the simple jump diffusion behavior. The data indicate that such small and/or highly charged ions break existing water structure and form complexes having local ordering and bonding similar to that of H_2O molecules in the corresponding solid salt hydrates. The strong ion-water coordinations and electrostriction of the solvent give rise to a higher activation energy for H_2O molecules than in pure water and these ions thus act as positive hydrators. Solutions of salts with larger singly charged ions (i.e., CsCl, KCl) also show new frequencies, but in contrast, at lower temperatures these are broader and less pronounced than for the smaller or highly charged ions. These solutions increase D and decrease τ_0 relative to pure water, acting as "negative hydrations." At higher temperatures maxima characteristic of ion-water coordinations appear more prominent and suggest that at such temperatures, relative to lower temperatures, the ion-water bonding may be more important than the H_2O-H_2O bonding in pure water. Values of the intermolecular frequencies, the diffusion coefficients, and residence times obtained were in reasonable numerical agreement with those obtained from other techniques. For cases where the delayed diffusion model is not valid, a tentative explanation for the observed diffusion kinetics has been presented. (auth)

6094 (NYO-3538-11) CHEMICAL LINKAGE OF THE 3,4-BENZPYRENE TO DNA VIA FREE RADICAL REACTION. Progress Report Attachment No. 8. Umans, R. S.; Lesko, S. A. Jr.; Ts'o, P. O. P. (Johns Hopkins Univ., Baltimore, Md.). Mar. 1, 1968. Contract AT(30-1)-3538. 7p. (CONF-681016-2). Dep. CFSTI.

From Physicochemical Mechanisms of Carcinogenesis Conference, Jerusalem, Israel.

Iodine was used to induce a reaction whereby a portion (10 to 20%) of 3,4-benzopyrene(BP), physically bound to native DNA, is chemically linked to the nucleic acid. The BP–DNA complex was hydrolyzed enzymatically to nucleotides. It is suggested that the BP–DNA bond is base labile, and thus might be cleaved by the alkaline conditions needed for enzymatic hydrolysis. (J.G.B.)

6095 (ORNL-TM-2387) TRENDS AND DIFFERENCES IN THE CRYSTALLIZATION BEHAVIOR OF LANTHANIDE HYDROXIDE PREPARATIONS. Haire, R. G.; Willmarth, T. E. (Oak Ridge National Lab., Tenn.). Oct. 1968. Contract W-7405-eng-26. 34p. (CONF-681020-1). Dep. CFSTI.

From 7th Rare Earth Research Conference, Coronado, Calif.

Hydroxide preparations of the lanthanides and yttrium were obtained by precipitating the metal ions from nitrate solutions with ammonium hydroxide. The gelatinous precipitates exhibited amorphous-like diffraction patterns immediately after precipitation. Colloidal solutions of the amorphous material were obtained by extensively washing the precipitates until peptization occurred. After sufficient periods of aging, the colloidal material crystallized and this crystallization process was studied using electron microscopy, electron diffraction, and x-ray analysis. The results showed that the lanthanides could be divided into two groups, based on the crystallizing times and the microstructures obtained for the hydroxides. Examination of the amorphous solutions of both groups showed that the material consisted of 20 to 50 Å particles. For the elements lanthanum through dysprosium, the aging times for crystallization were relatively short and the crystalline material appeared as rod or needle-like structures up to 2 μ in length and 0.4 μ in width. The diffraction patterns obtained for this group of elements indicated the structures were hexagonal. The second group of lanthanides and yttrium had long aging times and the crystalline material was in the form of fibrous rods or platelets. Platelets with edges up to 0.7 μ formed, and this type of structure appeared to be the predominant form for the second group. Preparations of the second group gave diffraction patterns which were more complex than the first group. Aging times for conversion to the crystalline form at ambient temperatures varied from minutes for lanthanum to several months for lutetium. Aging was more rapid at elevated temperatures and lutetium converted in less than 3 days at 80°C. (auth)

6096 MECHANISM OF CONTACT ELIMINATION. XXI. ISOTOPE EFFECT FOR HCl OR DCl ELIMINATION FROM VARIOUS DEUTERATED ISOCHLOROPROPANES ON $Mg_3(PO_4)_2$. Sitte, J.; Hunger, M.; Schmitz, E.; Noller, H. (Univ. Central de Venezuela, Caracas). Z. Naturforsch., 23b: 1384(Oct. 1968). (In German).

Microanalytical methods and infrared spectroscopy were used to study the HCl or DCl elimination from various deuterated gaseous isochloropropanes ($CH_3CHClCH_3$, $CH_3CDClCH_3$, and $CD_3CHClCD_3$) on a powdered $Mg_3(PO_4)_2$ catalyst. A qualitative evaluation of the absorption bands of the reactants and the products showed that in the monodeuterated substances the CD valence oscillation occurs whereas for the nondeuterated substances there is no characteristic skeleton oscillation. In Cl-propane-d_6 and its reaction products the CH valence oscillation is sharply expressed, but the relatively simple structure of the skeleton oscillation band indicates that CHD and CHD_2 groups are not present in significant concentration. The reaction is preponderantly of the type β. The reaction of the three reagents begins at about 480°K and is complete at 660°K. The slopes of the curves differ; the curves with no or one deuterium have no variation, but the curve of the d_6 reactant is displaced at a maximum of 20°C to higher temperatures. (J.S.R.)

6097 DIFFUSE SPECTRA OF SeH AND SeD. Lindgren, Bo (Univ. of Stockholm). J. Mol. Spectrosc., 28: 536-9(Dec. 1968).

Diffuse spectra attributed to SeH and SeD have been observed in the 3000 to 3250 Å region. From these observations the ground state dissociation energy can be estimated to $D_0'' = 3.2 \pm 0.2$ eV. (auth)

6098 LOW-TEMPERATURE SYNTHESIS OF 6 $ZrO_2.Nb_2O_5$ COMPOUND. Trunov, V. K.; Vladimirova, Z. A.; Komissarova, L. N.; Pol'shchikova, Z. Ya. (Moscow State Univ.). Neorg. Mater., 4: 457-8(Mar. 1968). (In Russian).

The synthesis of 6 $ZrO_2 \cdot Nb_2O_5$ specimens was achieved by coprecipitation of zirconium hydroxide and $Nb_2O \cdot XH_2O$ from a solution containing zirconium and niobium (with the ratio 1:3) and followed by annealing at various temperatures (from 450 to 950°C). X-ray phase analysis for the reflection planes (200), (020), and (002) showed that the size of crystallites varied linearly with the temperature from 500 to 900°C. At temperatures exceeding 900°C the size of the crystallites increased sharply. (R.V.J.)

6099 X-RAY DOUBLE-CRYSTAL METHOD OF ANALYZING MICROSTRAINS WITH BeO SINGLE CRYSTALS. Chikawa, Junichi (Univ. of Denver); Austerman, Stanley B. Advan. X-Ray Anal., 11: 394-400(1968).

From 16th Annual Conference on Applications of X-Ray Analysis, Denver, Colo. See CONF-670813.

A double-crystal arrangement was employed in the symmetrical Laue arrangement [(+n, −n) setting]. A perfect BeO crystal was used for the first crystal of the double-crystal spectrometer. To obtain a high x-ray intensity, the thickness of the crystal was made to correspond to a maximum of Pendellösung interference. A slit was placed between the first and second (specimen) crystals to select the x rays which precisely satisfy the Bragg condition. The slit was adjusted to avoid significant Fraunhofer diffraction. In this method, the incident beam for the specimen crystal was parallel enough to obtain intrinsic rocking curves of the specimen crystal. As an application, the method was used for determination of the senses of slight strains in BeO crystals. (auth)

6100 THE INFLUENCE OF SAMPLE SELF-ABSORPTION ON WAVELENGTH SHIFTS AND SHAPE CHANGES IN THE SOFT X-RAY REGION: THE RARE-EARTH M SERIES. Fischer, David W.; Baun, William L. (Air Force Materials Lab., Wright-Patterson Air Force Base, Ohio). Advan. X-Ray Anal., 11: 230-40(1968).

From 16th Annual Conference on Applications of X-Ray Analysis, Denver, Colo. See CONF-670813.

The Mα and Mβ emission spectra and the M_{IV} and M_V absorption spectra were studied for the entire series of rare earth elements. It is conclusively shown that the complicated multiplet structure observed in the emission spectra is not real emission structure but is, instead, produced by sample self-absorption. This is demonstrated by observing the emission spectra over wide variations in take-off angle and bombarding electron energies and finally by comparing the detailed structure of both the emission and absorption spectra. The M_{IV} and M_V absorption structure completely overlaps the Mα and Mβ emission lines, which are each found to have

but one intensity maximum when obtained under conditions of minimum self-absorption. Some of these spectra were not shown previously, while others were studied in detail. Points of agreement and disagreement with previous work are mentioned, and the wavelengths of the emission lines and absorption edges are listed for all of the rare earth elements. It is concluded that the 4f → 3d electron transitions are reversible in these elements. (auth)

6101 IR-ABSORPTION SPECTRA OF URANYL POLYNUCLEAR FLUORINE COMPOUNDS. Sergienko, V. I.; Davidovich, R. L. Izv. Sib. Otd. Akad. Nauk SSSR, No. 9, Ser. Khim. Nauk, No. 4, 71-7(July 1968). (In Russian).

Infrared spectra were obtained for solid $K_5(UO_2)_2F_9$, $K_3(UO_2)_2F_7 \cdot 2H_2O$, $M_2(UO_2)_3F_8 \cdot 4H_2O$, and $M(UO_2)_2F_5$ (where M is K or Rb) in the region 400 to 400 sm^{-1}, by use of ir-spectrometer UR-10. The presence of two bands of absorption assigned to asymmetrical stretching vibration of UO_2^{2+} group, can be explained by the unequivalence of these groups in the compound, arising from the different degree interaction between the central atom of uranium and the equatorial F-ligands. (auth)

6102 DETERMINATION OF THE HEAT OF FORMATION OF URANIUM TETRAFLUORIDE. Khanaev, E. I. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 9, Ser. Khim. Nauk, No. 4, 123-5(July 1968). (In Russian).

The heat of solution of the anhydrous stable form of uranium tetrafluoride in concentrated hydrochloric acid was determined. On this basis the UF_4 standard heat of formation was calculated. (auth)

6103 RUBIDIUM AND CESIUM URANYL FLUORIDES. Opalovskii, A. A.; Nesterenko, M. N. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 9, Ser. Khim. Nauk, No. 4, 13-17(July 1968). (In Russian).

Methods of synthesis of rubidium and cesium uranyl fluorides are proposed based on the reaction of uranium trioxide with aqueous solutions of rubidium and cesium fluorides of different concentration. The compounds prepared were studied by the methods of thermography, x-ray diffraction, ir spectra, and crystalloptics. (auth)

6104 NMR AND THE NATURE OF THE PHASE TRANSITIONS IN SOLID MoF_6 AND WF_6. Afanas'ev, M. L.; Gabuda, S. P.; Lundin, A. G.; Opalovskii, A. A.; Khaldoyanidi, K. A. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 9, Ser. Khim. Nauk, No. 4, 18-22(July 1968). (In Russian).

Solid MoF_6 and WF_6 were studied by the NMR method. The presence of the following modifications of MoF_6 was established: MoF_6 III, with rigid lattice; MoF_6 II, with effective cylindrical symmetry of molecules, MoF_6 I with effective spherical symmetry of molecules. Analogous regularity was observed for solid WF_6. (auth)

6105 POLAROGRAPHICAL STUDIES OF THE RARE-EARTH ELEMENTS IN FUSED NITRATES AND CHLORIDES OF ALKALINE METALS. Val'tsev, V. K.; Didora, N. F. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 9, Ser. Khim. Nauk, No. 4, 26-31(July 1968). (In Russian).

Polarographical behavior of the neodymium, praseodymium, samarium, and erbium nitrates was studied with stationary platinum electrodes on fused potassium background at 360°C. The direct proportionality of the wave height upon depolarizer concentration was established. Polarographical behavior of lanthanum, neodymium, and praseodymium chlorides was studied on background of fused mixture NaCl–KCl at 700°C. No direct proportionality was found between the limiting current value and depolarizer concentration. The half-wave potential was determined. The complexing capacity of neodymium was observed in fused salts. (auth)

6106 N,N-DIETHYLDITHIOCARBAMATE COMPLEXES OF CERTAIN TERVALENT LANTHANIDE AND ACTINIDE ELEMENTS. Brown, D.; Holah, D. G. (Atomic Energy Research Establishment, Harwell, Eng.). Chem. Commun., No. 23, 1545-6 (1968).

Quadrivalent actinide diethyldithiocarbamates of the type $M(dtc)_4$, where M = Th, U, Np, or Pu were characterized and consideration of the ionic radii of the tervalent lanthanides and actinides indicated that, on size considerations, it should be possible to prepare tervalent complexes of the type $M^I M^{III}(dtc)_4$, where M^I is a monovalent cation and M^{III} is a lanthanide or actinide element. Attempts were made to prepare neutral chelates of the type $M(dtc)_3$ (M = Np, Pu and La to Lu except Pm) by reaction between the appropriate anhydrous tribromide and the stoichiometric amount of sodium-dtc in anhydrous ethanol. $Pu(dtc)_3$ was isolated, but solutions of $Np(dtc)_3$ were rapidly oxidised to give crystalline $Np(dtc)_4$; the less stable U(III) compound was also oxidised to $U(dtc)_4$. Infrared studies suggested that the dtc groups are chelated in the usual manner. A structural change occurred within the lanthanide complexes, those of La to Nd forming one isostructural series, whilst those of Sm to Lu formed a second isostructural series. Despite the close similarity between the ionic radii of Pu^{3+} and Nd^{3+}, $Pu(dtc)_3$ possesses a structure different from either of the two structures shown by the lanthanides. By reaction of the $(dtc)_3$ complexes with sodium-dtc and tetraethylammonium bromide in alcohol, isostructural complexes of the type $N Et_4 M(dtc)_4$ (M = Np, Pu, and La to Lu excepting Pm) were obtained. It is possible that these complexes may represent first examples of tervalent metal ions showing 8-coordination with sulphur chelates. Crystallographic properties are tabulated for $Nd(dtc)_3$, $Eu(dtc)_3$, and $NEt_4Eu(dtc)_4$. (UK)

6107 ELECTRIC CONDUCTIVITIES OF FUSED UCl_3 AND NaCl–UCl_3 SYSTEMS. Mochinaga, Junichi; Cho, Kangjo (Tokyo Inst. of Tech.). Denki Kagaku, 36: 746-8(Oct. 1968). (In Japanese).

Electric conductivities of molten UCl_3 and fused NaCl–UCl_3 salt mixtures were measured using 1000 Hz ac bridge. The following empirical expression for the specific conductivity of the molten UCL_3 as a function of temperature was obtained: $\kappa = 0.953 + 1.53 \times 10^{-3}(t - 850)$ # $870 < t < 950$, where t: temperature (°C), and κ: specific conductivity ($ohm^{-1}\ cm^{-1}$). The results of specific conductivity measurements of NaCl–UCl_3 binary salt mixtures showed that at lower concentrations than the eutectic composition a maximum appeared on specific conductivity vs. temperature curve above 850°C. (NSA of Japan)

6108 STUDIES IN ELECTROGENERATIVE HYDROGENATION. Feiz, Iraj. Madison, Wis., Univ. of Wisconsin, 1968. 409p.

Thesis.

Isotope tracer techniques were extended to electrochemical kinetic studies in order to characterize and evaluate the reactions occurring at the cathode of an electrogenerative hydrogenation system. Deuterium was reacted with unsaturated hydrocarbon gases on a Pt black electrocatalyst using a deuteroperchloric acid electrolyte. A technique was developed for sampling, separation, and analysis of the products by a combination of gas chromatography and mass spectrometry. The results indicated close resemblance to conventional catalytic hydrogenation. It was proposed that the hydrogenation and exchange reactions took place after the discharge of atomic D at the cathode, and mechanisms involving carbonium ions could be ruled out. Existence of all the possible deuterated species in the products indicated that a half-hydrogenated intermediate was included in the reaction. Optimization of the statistical parameters of a previously proposed, four parameter model for the catalytic hydrogenation of ethylene, by a regression analysis, unmasked the relative rates of the proposed basic steps. In the electrogenerative deuteration of propylene and cyclopropane, the net rates of the intermediate steps were determined by using a single parameter based on the probabilities of adding H or D to the alkyl radical. A high propyl reversal rate was indicated in the adsorbed state. Electrogenerative hydrogenation studies at elevated temperatures in a continuous free electrolyte cell indicated currents of about 80 ma/cm^2 at 70°C for ethylene and propylene, as compared to the values of about 18 ma/cm^2 at 25°C. For acetylene, which reacts slowly at room temperature, the current density increased eight-fold on raising the temperature to 75°C. Since ethylene was the major product, desorption was thought to play an important role in determining the ethylene : ethane ratio. Gas and liquid permeability studies in porous plastic media were used to evaluate commercially available plastics as backing for fuel cell electrodes. A composite free electrolyte electrode, fabricated by bonding a porous polytetrafluoroethylene membrane to a matrix type fuel cell electrode, performed better than a commercial electrode in electrogenerative hydrogenation of ethylene. Convective gas transport was thought to be the predominant flow mechanism in the porous membranes tested. (Diss. Abstr.)

6109 DEUTERIUM BOND ASSOCIATION AND CONCENTRATION-DEPENDENT VAPOR PRESSURE ISOTOPE EFFECT OF METHANOL IN n-HEXANE. Wolff, H.; Hoeppel, H.-E. (Univ., Heidelberg). Ber. Bunsenges. Phys. Chem., 72: 722-5 (Oct. 1968). (In German).

A determination of the vapor pressure isotherms of the system CH_3OD-n-hexane at temperatures between 35 and 75°C and application of the pressure for calculation of the characteristic quantities and excess functions for association of deuterated methanol gives results that correspond with those found for the system using the nondeuterated compound. Among other things, in calculation according to Barker's method, the number of Redlich-

Kister constants required for representation of the activity coefficients decreases from about 11 at 35°C to 6 at 75°C. Distribution of the monomers and the associates, the average degree of polymerization, the heat of vaporization and the association energy, which was found to be 6.5 to 7 kcal/mol, suggest, however, that the energy of the deuterium bridge is somewhat greater than that of the hydrogen bridge. Just as in the explanation of the vapor-pressure isotope effect for substances forming hydrogen bonds in terms of the inter- and intramolecular vibration of the associates, the trend in the partial pressure ratios p^D/p^H for mole fractions of methanol below 0.05 shows a tendency to pass from the normal effect ($p^D < p^H$) to an inverse effect ($p^D > p^H$). The latter is related to the solvent shift. (auth)

6110 STUDIES OF THE EQUILIBRIUM ISOTOPE EFFECT ON THE ACID DISSOCIATION CONSTANT OF THE AQUOPENTAMMINECOBALT(III) CATION; KINETICS OF DIMERIZATION OF MONOHYDROXODIMETHYLTIN(IV) AQUO CATION BY THE FLOW METHOD. Splinter, Roger Carl. Minneapolis, Univ. of Minnesota, 1968. 149p.

Thesis.

The equilibrium isotope effect on the acid dissociation constant of the aquopentamminecobalt(II) ion in protium and deuterium oxide was determined. Acid dissociation constants were determined for $[Co(NH_3)_5OH_2]^{3+}$, $[Co(NH_3)_5OD_2]^{3+}$ and $[Co(NO_3)_5OD_2]^{3+}$ in order to determine the magnitude of the isotope effect, log K_H/K_D, and to determine if any secondary isotope effect is observed due to the exchange of the amine hydrogens with the D_2O solvent. The acid dissociation constants were measured in protium and D_2O by a standard emf technique, a fast titration technique, and flow system measurement. Exchange of the amine hydrogens was studied by use of the near infrared spectrum. The systems studied and equilibrium constant found are: $Co(NH_3)_5OH_2^{3+} + H_2O = Co(NH_3)_5OH^{2+} + H_3O^+$, pK = 6.217 ± 0.004; $Co(NH_3)_5OD_2^{3+} + D_2O = Co(NH_3)_5OD^{2+} + D_3O^+$, pK = 6.748 ± 0.001; and $Co(NO_3)_5OD_2^{2+} + D_2O = Co(NO_3)_5OD^{2+} + D_3O^+$, pk = 6.702 ± 0.002. The observed first order rate constant for the exchange of the amine hydrogens with D from the solvent D_2O is 0.054 ± 0.005 $min.^{-1}$. The construction of a "continuous flow" flow system and the subsequent use of this system to study the kinetics of dimerization of the conjugate base of the dimethyltin aquo cation is described. The "continuous flow" flow system is constructed so that two reactant solutions may be mixed together rapidly and measurements may be made of the hydrogen ion as a function of time on the resulting streaming solution. Since the condensation reaction for investigation of the dimerization of $[(CH_3)_2SnOH]^+$ to give the di-μ-hydroxo bridged species, $[(CH_3)_2Sn(OH)_2Sn(CH_3)_2]^{++}$ was too rapid to be studied quantitatively with the above mentioned flow system or by nmr techniques, the conclusion drawn from the measurements is that the reaction $2(CH_3)_2SnOH^+ \rightleftharpoons (CH_3)_2Sn(OH)_2Sn(CH_3)_2^{2+}$ has a half-life of less than 3 msec. (Diss. Abstr.)

6111 COORDINATION CHEMISTRY OF URANIUM(IV) AND URANIUM (V). Ortego, James Dale. Baton Rouge, La., Louisiana State Univ. and Baton Rouge, La., Agricultural and Mechanical Coll., 1968. 156p.

Thesis.

Several coordination compounds of U(IV) and U(V) were synthesized and characterized. Physical-chemical studies carried out with these new compounds included magnetic susceptibility measurements and infrared, visible, and near-infrared spectral studies, in addition to other characterizing methods such as the determination of melting points, solubilities, conductivities, and thermal stabilities. Included among these compounds is a unique phosphorus-donor complex of uranium tetrachloride [$2UCl_4 \cdot$ ethylenebis(diphenylphosphine)]; a complex in which the U(IV) ion is coordinated to two quadridentate ligand molecules [U(ethylenediaminebis(salicylaldehyde))$_2$]; and a volatile U(IV) complex with the ligand dipivaloylmethane [U(dpm)$_4$]. Nitrogen-donor complexes of U(IV) were prepared with the ligands ethylenediamine [$UCl_4 \cdot$ 4en], pyridine [$UCl_4 \cdot 2py$], piperidine [$UCl_4 \cdot 4pip$], 2-pyridinecarboxaldehyde [$UCl_4 \cdot$ (2-pyc)$_2$], di-2-pyridyl ketone [$2UCl_4 \cdot 3dpk$], 2-amino-3-hydroxypyridine [$UCl_4 \cdot 4ahp$], aniline [$UCl_4 \cdot 2anil$], and o-phenylenediamine [$UCl_4 \cdot 2pen$]. In general, these addition compounds are very hygroscopic, are thermally unstable and show slight solubilities in organic solvents. Other complexes of U(IV) with oxygen-donor ligands included compounds with kojic acid [U(koj)$_4$], chlorokojic acid [U(Cl–koj)$_4$], salicylaldehyde [U(sal)$_4$], ethylenebis(diphenylarsine oxide) [$UCl_4 \cdot$ (diarso)$_2$], dimethyl sulfoxide [$UCl_4 \cdot 4DMSO$], and diphenyl sulfoxide [$UCl_4 \cdot 3Ph_2SO$]. As a group, these oxygen-donor compounds are more stable, they exhibit higher melting points and show a wider range of solubilities in organic solvents. Electronic and vibrational spectral data were used to obtain evidence for possible 10-coordination in tropolone ($T = C_7H_5O_2^-$) complexes of U(IV) and Th(IV). Results indicate 10-coordination in the solid $LiUT_5$ and $LiThT_5$ compounds, but dissociation in solution (DMSO and DMF) to yield an 8-coordinate species. Some new compounds of uranium(V) prepared in this study included $UCl_5 \cdot$ TCAC (TCAC = trichloroacrylyl chloride), $RbUCl_6$ and $Pr_4^{IV}NUCl_6$. From electronic spectral studies it was found possible (from vibronic bands) to assign vibrational modes of the hexachlorouranate(V) anion. The sharp, well-defined peaks found in the electronic absorption spectrum allows assignment of the three odd vibrational modes $\nu(T_{1u})$, $\nu_4(T_{1u})$ and $\nu_6(T_{2u})$ at 312, 121 and 92 cm^{-1}, respectively. (Diss. Abstr.)

6112 RAMAN AND INFRARED SPECTRAL DATA FOR CH_2Br_2, $CHDBr_2$, AND CD_2Br_2. Dennen, Robert S.; Piotrowski, Edward A.; Cleveland, Forrest F. (Illinois Inst. of Tech., Chicago). J. Chem. Phys., 49: 4385-91(Nov. 15, 1968).

Raman displacements, relative intensities, and depolarization ratios were observed for CH_2Br_2, CD_2Br_2, and $CHDBr_2$ in the liquid phase, and the wavenumbers and relative intensities for the infrared bands from 400 to 4000 cm^{-1} were obtained for both the liquid and vapor phases. All but five of the 90 bands observed for the liquid phases of these methanes were assigned to fundamentals, first overtones, and binary combinations. The assignments for the fundamentals of CH_2Br_2 are in agreement with previous assignments of Plyler, Smith, and Acquista, but the assignment for the b_1 fundamental of CD_2Br_2 at 2313 cm^{-1} differs from that of Dowling. The assignments for CD_2Br_2 were made by comparison with those for CH_2Br_2, and those for $CHDBr_2$ were made with the aid of the Brodersen and Langseth complete isotopic rule. The present assignments are in better agreement with that rule than are the previous assignments. (auth)

6113 LUMINESCENCE BEHAVIOUR OF URANIUM ACTIVATED RUBIDIUM FLUORIDE PHOSPHOR. Sanwal, D. N.; Tripathi, H. B.; Pant, D. D. (Government Coll., Naini Tal, India). Indian J. Pure Appl. Phys., 6: 580-1(Oct. 1968).

A new phosphor, uranium activated rubidium fluoride [RbF(U)], prepared by fusing RbF with 0.1% uranium by weight in an oxidizing flame, was found to have luminescence behavior different from that of LiF(U) and NaF(U). The temperature variation of the total intensity and of the rate constant were studied and the parameters α_0, ΔE_1 and ΔE_2 were calculated. (auth)

6114 PROBLEMS IN RADICAL POLYMERIZATIONS. I. THE ISOTOPE EFFECT ON HYDROGEN ABSTRACTION FROM CHLOROFORM BY THE POLYSTYRYL RADICAL. II. THE TRANSFER CONSTANT OF AIBN. III. A SCALE OF PHENYL AFFINITIES. Fiske, Thomas Raymond. Baton Rouge, La., Louisiana State Univ. Baton Rouge, La., Agricultural and Mechanical Coll., 1968. 154p.

Thesis.

The transfer constants of chloroform-^3H and chloroform-^{14}C toward the polystyryl radical were measured by a tracer technique. The values obtained were 6.72×10^{-6} and 4.83×10^{-5}, respectively. This corresponds to a tritium isotope effect of 7.2. The transfer constants of chloroform and chloroform-^2H toward the polystyryl radical were measured by the classical molecular weight technique. The values obtained for the transfer constants of chloroform and chloroform-^2H by the classical molecular weight technique were 4.64×10^{-5} and 1.10×10^{-5}, respectively. This corresponds to a deuterium isotope effect of 4.2. The relationship of the two isotope effects agrees, within experimental error, with that calculated using the Swain equation, and the seemingly low isotope effects are rationalized using recent theories of isotope effects. The transfer constant of AIBN toward the polystyryl radical was measured by a tracer technique. The value obtained was 1.7×10^{-2}. In an effort to rationalize this high value, a study of model compounds was made. The transfer constants of tetramethylsuccinodinitrile and trimethylacetonitrile toward the polystyryl radical were determined by the classical molecular weight technique. The values obtained were 3.7×10^{-5} and 3.8×10^{-5}, respectively. A discussion of the possible reasons for the obtained value of the transfer constant of AIBN is presented. Limits are suggested for the transfer constant of AIBN. A method was devised by which the rate of addition of the phenyl radical to olefins is related to the rate of T abstraction from heptanethiol-^3H. The system allows one to compare the relative affinities of a series of olefins for the phenyl radical. The relative reactivities obtained show that the polystyryl and methyl radicals are, respectively, 2.37 and 1.73 times more selective than the phenyl radical in additions to olefins. A rationalization for the low selectivity of the phenyl radical is presented. (Disser. Abstr.)

6115 CRYSTAL CHEMISTRY OF RADIUM. II. RADIUM SALTS OF THE TYPE $RaXO_4$, X = S, Se, Cr, Mo, W. Weigel, F.; Trinkl, A. (Univ., Munich. Technische Hochschule, Garching, Ger.). Radiochim. Acta, 9: 140-4(Aug. 1968). (In German).

In the course of crystal chemical studies on radium compounds,

a number of salts of the type $RaXO_4$ were prepared in micro scale experiments, and their x-ray patterns were obtained. Physical properties of $RaSO_4$, $RaSeO_4$, $RaCrO_4$, $RaMoO_4$, and $RaWO_4$ are tabulated. All salts studied are isomorphous with the corresponding barium salts. (auth)

6116 APPLICATION OF THE INTEGRATED ION-CURRENT TECHNIQUE TO THE STUDY OF RARE EARTH CHELATES. Belcher, R.; Majer, J. R.; Perry, R.; Stephen, W. I. (Univ. of Birmingham, Eng.). Anal. Chim. Acta, 43: 451-8(1968).

Several substituted acetylacetones were prepared and reacted with holmium to give tris chelates of the form HoL_3. One of these chelates was converted to a tetrakis chelate of the form $NaHoL_4$. The mass spectra of these compounds was studied and the integrated ion currents at significant m/e values were related to the amounts of metal chelates evaporated into the ion source of the mass spectrometer. The shape of the integrated ion-current curve is shown to give information about the nature of the evaporation process. When the β-diketone (L) is asymmetrical as in the case of 1,1,1-trifluoro-5,5-dimethylhexan-2,4-dione, the existence of geometrical isomers of the chelate, HoL_3, is reflected in the shape of the integrated ion-current curve, which shows fine structure. The results of mass spectrometric studies are compared with those of the sublimation and gas chromatographic behavior of the metal chelates. (auth)

6117 THE CRYSTAL STRUCTURE OF POTASSIUM BIS-(TRICYANOVINYL)AMINE. NUCLEAR MAGNETIC RESONANCE STUDIES OF ALKALI HALIDE SOLUTIONS. ELUCIDATION OF THE INTRAMOLECULAR HYDROGEN BOND IN ACETYLACETONE BY THE DEUTERIUM ISOTOPE EFFECT ON THE CHEMICAL SHIFT OF THE BRIDGE HYDROGEN. Lin, Leroy Chi-tsun. Pasadena, Calif., California Inst. of Tech., 1968. 172p.

Thesis.

Potassium bis-(tricyanovinyl)amine, $K^+N[C(CN)=C(CN_2)]_2^-$, crystallizes in the monoclinic system with the space group Cc and lattice constants, a = 13.346 ± 0.003 Å, b = 10.191 ± 0.001 Å, c = 8.992 ± 0.003 Å, B = 114.42 ± 0.02°, and Z = 4. Three dimensional intensity data were collected by layers perpendicular to b* and c* axes. The crystal structure was refined by the least squares method with anisotropic temperature factor to an R value of 0.064. The nuclear magnetic resonance of ^{81}Br and ^{127}I in aqueous solutions was studied. The cation-halide ion interactions were studied by studying the effect of the Li^+, Na^+, K^+, Mg^{2+}, Cs^+ upon the line width of the halide ions. The solvent-halide ion interactions were studied by studying the effect of methanol, acetonitrile, and acetone upon the line width of ^{81}Br and ^{127}I in the aqueous solutions. It was found that the viscosity plays a very important role upon the halide ions line width. There is no specific cation-halide ion interaction for those ions such as Mg^{2+}, Li^+, Na^+, and K^+, whereas the Cs^+-halide ion interaction is strong. The effect of organic solvents upon the halide ion line width in aqueous solutions is in the order acetone > acetonitrile > methanol. It is suggested that halide ions do form some stable complex with the solvent molecules and the reason Cs^+ has an unusually large effect upon the halide ion line width is mainly due to the effect that Cs^+ can replace one of the ligands in the solvent-halide ion complex. An unusually large isotope effect on the bridge hydrogen chemical shift of the enol form of 2,4-pentanedione (acetylacetone) and 3-methyl-2,4-pentanedione has been observed. An attempt has been made to interpret this effect. It is suggested from the deuterium isotope effect studies, temperature dependence of the bridge hydrogen chemical shift studies, ir studies in the OH, OD, and C=O stretch regions, and the HMO calculations, that there may probably be two structures for the enol form of acetylacetone. The difference between these two structures arises mainly from the electronic structure of the π-system. The relative population of these two structures at various temperatures for normal acetylacetone and at room temperature for the deuterated acetylacetone were calculated. (TSS) (Disser. Abstr.)

6118 REACTIONS OF SINGLET AND TRIPLET METHYLENE. Ring, David Francis. Seattle, Univ. of Washington, 1968. 228p.

Thesis.

A study of the pressure dependence of the C_5 products of the reaction between cis-butene-2 and triplet methylene radicals is reported. Triplet methylene was produced by collisional deactivation (in the presence of a large excess of nitrogen) of the methylene produced by the photolysis of diazomethane with 4358 Å radiation at 23°C, and with unfiltered light at 23 and 56°C, and reaction pressures were varied from 0.3 to 3.5 atm. A constant ratio of cis-butene-2 : diazomethane : nitrogen was maintained at 20 : 1 : 30,000. The observed pressure dependence of the product proportions indicates that alkene products arise in part by isomerization of the triplet dimethylcyclopropanes or diradicals, rather than exclusively by a concomitant, noninterceptible formation reaction. Studies were made of products resulting from reaction between triplet methylene and several alkanes, propane, n-butane, and isobutane. Complicating side reactions involving diazomethane were encountered. Observation of higher products allowed the determination of the relative rates of 1° : 2° : 3° H abstraction from C–H bonds; these are ~1 : 14 : 150. The rate of addition of $^3CH_2$ to the C=C bond in ethylene appears to proceed ~3.5 times faster than H abstraction from a 3° C–H bond. The possible occurrence of insertion by $^3CH_2$ into C–H bonds is discussed and relative rates of insertion for 1° : 2° : 3° bonds are deduced to be ~1 : 2 : 7. Comparisons of the relative rates of insertion : abstraction are also given. Studies with propane-d_8 indicated an isotope effect for abstraction of H : D from the 1° position of ~3.9; insertion by $^3CH_2$ into the same position showed an isotope effect of ~2. A study of the pressure dependence of the C_5 products from the reaction of cis-butene-2 and methylene is reported. Methylene was produced by photolysis of diazomethane at 4358 Å and 23 or 56°C and photolysis of ketene at 3130 Å and 23 or 100°C. Possible causes of the relative change in yield, with increasing pressure, of the characteristically triplet products, trans-1,2-dimethylcyclopropane (TDMC), trans-pentene-2 (TP2) and 3-methylbutene-1 (3MB1) with respect to the singlet products, cis-1,2-dimethylcyclopropane (CDMC) and cis-pentene-2 (CP2) are discussed. Relative rates of reactions for singlet methylene with primary CH : vinyl-CH : C=C in the gas phase were found to be ~1 : 1.1 : 3.7 for the diazomethane systems and ~1 : 1.3 : 5.2 for the ketene work. Results of experiments performed in the neat liquid in diazomethane systems were 1 : 1.1 : 7.2 and in ketene systems were 1 : 1.3 : 6.7 for the same bonds, respectively. Measurements of deuterium isotope effects on the rates of methylene insertion into C–H and C–D bonds are reported. The isotopic ratio, k_H/k_D, for methylene insertion into the carbon-hydrogen bonds of cyclopropane is 1.29; that for cyclohexane is 1.32. (Disser. Abstr.)

6119 H–D ISOTOPE EFFECTS IN CRYSTALLINE-FLUID ALKOXYBENZOIC ACID. Kolbe, A.; Demus, D. (Univ., Halle, Ger.). Z. Naturforsch., 23a: 1237(Aug. 1968). (In German).

The effects of the substitution of D for the H atoms in the alkyl chain in alkoxybenzoic acids on the conversion temperatures were studied. The melting points, smectic C-nematic transformations, and clarification points were measured for undeuterated and deuterated acids with 4, 5, 6, 7, 8, 9, 10, and 12 C atoms in the alkyl chain. The transformation temperatures were all decreased by deuteration, with the smallest effect on the melting points. Measurements made on butoxybenzoic acid showed that the modification of the transformation temperatures by deuteration is caused partially by modification of the properties of the dimer molecule and partially by increase of the monomer constituent. (J.S.R.)

6120 COMPLEX FORMATION OF CERIUM AND YTTRIUM WITH AMINOOXYPROPIONIC ACID. Rogozina, E. M.; Popov, D. K.; Ponikarova, T. M. Radiokhimiya, 10: 593-6(1968). (In Russian).

Complex formation of yttrium and trivalent cerium with 2-(aminooxy)propionic acid in aqueous solutions was studied using potentiometric titration and the method of relative absorption curves. The instability factor for complex compounds of trivalent cerium and yttrium in serine composition was found to be 1 : 1. (R.V.J.)

6121 CERIUM(IV), THORIUM(IV), AND U(IV) HEXATHIOCYANIC CHROMATE COMPLEXES WITH AMIDOPYRINE, ANTIPYRINE, PYRIDINE, AND DIMETHYL FORMAMIDE. Merkusheva, S. A.; Skorik, N. A.; Serebrennkov, V. V. Radiokhimiya, 10: 591-3(1968). (In Russian).

The synthesis, analysis, and properties of hexathiocyanate chromate cation complexes of $[Me(Am)_x]^{4+}$, where Me is Ce^{4+}, Th^{4+}, U^{4+} and Am is 4-(dimethylamino)antipyrine, antipyrine, pyridine, and dimethyl formamide, and x is equal to 6 or 8. The density of prepared hexathiocyanate salts with antipyrine $[Me(C_{11}H_{12}ON_2)_6]_3$ $[Cr(SCN)_6]_4$, with 4-(dimethylamino)antipyrine $[Me(C_{13}H_{17}ON_3)_6]$ $[Cr(SCN)_6]_4$, with dimethylformamide $[Me(C_3H_7ON)_8]_3$ $[Cr(SCN)_6]_4$, and with pyridine $[Me(C_5H_5N_2)_8]_3$ $[Cr(SCN)_6]_4$ and their solubility in water at 25°C were determined. (R.V.J.)

6122 DETERMINATION OF THE STABILITY CONSTANTS OF SOME LANTHANON COMPLEXES WITH 1-NITROSO-2-NAPHTHOL, 2-NITROSO-1-NAPHTHOL, AND 3-NITROSO-4-HYDROXYCOUMARIN. Manku, G. S.; Gupta, R. D.; Bhat, A. N.; Jain, B. D. (Univ. of Delhi). J. Less-Common Metals, 16: 343-50(1968).

The stability constants of the complexes of 1-nitroso-2-naphthol,

(I), 2-nitroso-1-naphthol, (II), and 3-nitroso-4-hydroxycoumarin, (III), with La(III), Ce(III), Pr(III), Nd(III), Sm(III), Gd(III), Dy(III), Ho(III), Er(III), Tm(III), Yb(III), Lu(III), and Y(III) have been determined in 50% aqueous dioxan (v/v) at 21°C by pH titrations using the Bjerrum–Calvin technique. Log β_1 for the lanthanon complexes with these ligands increased with increasing atomic number, that for the Y(III) complexes being equal to the value for Ho(III) complexes. For all the lanthanons, log β_1 decreased with decreasing pK_a of the ligands. (auth)

6123 REACTION OF 5,5'-DITHIOBIS(2-NITROBENZOIC ACID) WITH MERCAPTANS AND PROTEIN MERCAPTO GROUPS. Airee, Shakti Kumar. Stillwater, Okla., Oklahoma State Univ., 1967. 108p.

Thesis.

The interchange reactions of the disulfide 5,5'-dithiobis (2-nitrobenzoic acid) (nbSSbn) with the enzyme alcohol dehydrogenase from yeast (YADH) were studied. The effect of the reaction on the catalytic activity was investigated. The effect of several other mercapto group reagents and of x-irradiation on YADH was studied and compared to that of nbSSbn. The reaction of nbSSbn with some other proteins was studied to some extent, as well as the reaction with simple mercapto compounds. In all these reactions, nbSSbn was converted to nbS^-, which has a characteristic absorption in the visible; spectrophotometry was accordingly used to identify and determine this product. Reaction of nbSSbn with sodium borohydride gave the same product as the reaction with simple mercapto compounds and proteins. The product in all cases was nbSH and nbS^-. The ionization constant of nbSH was determined: pK = 4.4 at μ = 0.12. The molar absorbency of nbS^- is 1.36×10^4 l/mole-cm at 410 mμ. The reaction of nbSSbn with cysteine, 2-mercaptoethanol, and glutathione proceeded at a measurable rate at pH 5.0. Initial rates were first order in each of the reactants and decreased in the order: 2-mercaptoethanol > cysteine > glutathione. The stoichiometry of the reaction of nbSSbn with cysteine, β-lactoglobulin, and ovalbumin is shown by the equations (1), (2), and (3), respectively:

$$2\ \text{P-SH} + \text{nbSSbn} = \text{P-SS-P} + 2\ \text{nbSH} \quad (1)$$

$$\text{P-SH} + \text{nbSSbn} = \text{P-SS-bn} + \text{nbSH} \quad (2)$$

$$\text{and } \text{P}\begin{matrix}\text{-SH}\\\text{-SH}\end{matrix} + \text{nbSSbn} = \text{P}\begin{matrix}\text{-S}\\\text{-S}\end{matrix} + 2\ \text{nbSH} \quad (3)$$

A method of preparation of YADH was devised, and the effect of other parameters on the purity and yield of the enzyme was compared. The reaction of YADH with the following mercapto-group reagents was examined: p-chloromercuribenzoate, N-ethylmaleimide, ferricyanide, iodine, and nbSSbn. p-Chloromercuribenzoate and nbSSbn were most suitable for mercapto-group determinations in this enzyme. The inactivation yield of YADH on x-irradiation was found to be 0.1 molecules/100 eV. There was no competition from the medium for the inactivating species first formed in the irradiation process. The destruction of titrable mercapto groups on irradiation was much less than the decrease in activity. It was found that about four mercapto groups react much faster than the rest and their disappearance does not affect the activity, and activity of the irradiated YADH is completely lost when all the mercapto groups of the enzyme have reacted with nbSSbn. (Disser. Abstr.)

6124 STUDIES IN THE STEREOCHEMISTRY OF BRIDGED BIPHENYLS. I. STERIC HYDROGEN ISOTOPE EFFECTS. II. PHOTOCHEMICAL RACEMIZATIONS. Gordon, Arnold Jacob. New York, Univ. of New York, 1964. 237p.

Thesis.

Specifically deuterated optically active 9,10-dihydro-4,5-dimethylphenanthrenes (I) were synthesized; abundance of the various isotopic isomers and precise location of D atoms were determined by a combination of mass spectral, NMR, and combustion analyses. Individual rate constants for racemization in benzene were calculated by linear and non-linear least square codes. For the compounds (I) and I-d_6 the isotope effect was solvent independent (benzene, heptane, ethanol) and the temperature dependence of k_D/k_H in heptane or benzene gave $\Delta H_H^{\ddagger} - \Delta H_D^{\ddagger}$ = 232 cal/mole and $\Delta S_H^{\ddagger} - \Delta S_D^{\ddagger}$ = 0.484 eu. This provides the first direct and unequivocal demonstration of a steric secondary kinetic deuterium isotope effect. The enthalpy (steric) effect manifests itself in the strikingly small value of ~60 cal/mole/D atom. Optically active 5,7-dihydro-1,11-dimethyl-6H-dibenzo [a,c]-cycloheptene-6-one (II) photolytically decarbonylates when irradiated for 6 hr above 222 or 280 mμ (450 watt Hg arc) in ether solution at 25°C; a 35 to 50% yield of optically active (I) was formed. In addition, unreacted II suffers a loss of up to 8% in optical purity. Optically active 6,7-dihydro-1,11-dimethyl-5H-dibenzo[a,c]-cycloheptene (III) also photoracemizes but only when radiation includes the region 222 to 280 mμ. Depending on conditions the optical half-life of III is 2 to 30 hr. Both II and III are optically stable below 150°C; their energies of activation for thermal racemization are 36 and 39 kcal/mole, respectively. Photoracemization of II and III provides the first example of light induced interconversion of torsional single-bond stereoisomers. (Disser. Abstr.)

6125 VOLTAMMETRY OF NEPTUNIUM(VI) MALONATE AT THE ROTATED GLASSY CARBON ELECTRODE. Plock, C. E. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. J. Inorg. Nucl. Chem., 30: 3023-32(Nov. 1968).

The voltammetric behavior of Np(VI) malonate was investigated over widely varying conditions of ligand concentration and pH. Under the conditions investigated, an irreversible wave was obtained at pH > 3.3 and the ligand concentration was $< 6.0 \times 10^{-2}$ M. In all other pH ranges and ligand concentrations a reversible wave corresponding to the reduction of the Np(VI) complex to the Np(V) complex was obtained. At acid concentrations > 1 M and pH < 3.3 the half wave potential was found to be independent of acid concentration. Inside this range the half wave potential is pH dependent, and one hydrogen ion is involved in the reduction. The metal-ligand ratio was found to be 1 : 2 by conductometric titrations. The limiting current is proportional to the concentration of the Np(VI) from 3.92×10^{-5} to 1.96×10^{-3} M. The diffusion coefficient is 0.28×10^{-5} cm²/sec at pH 1.3 and 0.22×10^{-5} cm²/sec at pH 4.6. (auth) (UK)

6126 DEUTERIUM ISOTOPE EFFECTS IN THE NORRISH TYPE II ELIMINATION OF A KETONE WITH MULTIPLE AVAILABLE SITES. Padwa, A.; Bergmask, W. (State Univ. of New York, Buffalo). Tetrahedron Lett., No. 55, 5795-8(Nov. 1968).

Substitution of the γ-H by D was known to exert a profound effect on Norrish Type II photoelimination in ketones. An examination was made of the influence of γ-D substitution on the quantum efficiency and distribution of photoproducts from 5-decanone(I) and 5-decanone-2,2-d_2(II). Quantum yields for production of 2-hexanone and 2-heptanone are tabulated. The molar ratio of 2-hexanone/2-heptanone from (I) was 0.895 ± 0.02, and from (II) was 4.45 ± 0.02. Results verified that a γ-H is considerably more reactive than a γ-D in the type II process for aliphatic ketones. In contrast to the 2-hexanone system, the 5-decanone system shows a decreased overall quantum yield and appears to be much more a singlet state reaction, and it appears that the additional hydrogens available to the excited carbonyl tend to promote both product formation and internal conversion from the singlet state. While the overall quantum yield for ketone disappearance decreases with D substitution, the quantum yield from the triplet state increases slightly, lending support to the contention that D substitution enhances intersystem crossing to the more efficient triplet. (UK)

6127 DEUTERIUM ISOTOPE EFFECT ON GEMINAL COUPLINGS BETWEEN PROTON AND FLUORINE NUCLEI. Banwell, C. N.; Murrell, J. N.; Turpin, M. A. (Univ. of Sussex, Brighton, Eng.). Chem. Commun., No. 23, 1466-7(1968).

It is stated that an isotope effect was observed on the geminal proton-fluorine coupling constant in fluoroform and silyl fluoride by NMR techniques; such studies may provide some understanding of the variation of geminal coupling constants with nuclear configuration. Results are presented in tabular form. The isotope effect for fluoroform was 0.078 ± 0.048 Hz, which is just significant, and for silyl fluoride the value was 0.153 ± 0.052 Hz. In both cases the effect was such that deuteration caused a decrease in the absolute magnitude of the coupling constant. (UK)

6128 CONDITIONS FOR REDUCTION OF SMALL AMOUNTS OF EUROPIUM. Gromova, M. I.; Litvina, M. N.; Peshkova, V. M. Vestn. Mosk. Univ., Ser. II. Khim., No. 5, 98-100(Sept.-Oct. 1968). (In Russian).

The conditions for quantitative reduction of Eu(III) by amalgamated zinc in Jones reductor and for quantitative elution of Eu(II) from reductor in the range 0.80 to 1.60 mg in 15 to 20 ml of 0.05 n HCl were described. (auth)

6129 FORMATION OF COMPLEX HYDRATES FROM URANIUM PENTAFLUORIDE AND THE HYDRATED DIFLUORIDES OF COBALT, NICKEL, AND COPPER. Montoloy, Francois; Plurien, Pierre (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. C, 267: 1036-8 (Oct. 21, 1968). (In French).

By the reaction of β UF_5 and of $CoF_2 \cdot 4H_2O$, $NiF_2 \cdot 4H_2O$, or $CuF_2 \cdot 2H_2O$ in hydrofluoric acid medium there were obtained, by precipitation, the complexes corresponding to the formula: $M^{II}U_2^{V}F_{12} \cdot 4H_2O$ (M = Co, Ni, Cu). (tr-auth)

6130 MIXED POLYNUCLEAR CITRATE COMPLEXES OF NEODYMIUM AND CERTAIN OTHER METALS. Lauer, R. S.;

Mishchenko, V. T.; Poluektov, N. S. Zh. Neorg. Khim., 13: 2415-20(Sept. 1968). (In Russian).

It was established that the absorption spectra of citrate complexes of neodymium are definitely changed in the presence of citrate complexes of such metals as Zn, Cd, Sn^{2+}, Pb^{2+}, Al, Sc, In^{3+}, Fe^{3+}, Sb^{3+}, Bi^{3+}, Ti^{4+}, Zr, Th, and U^{6+}, thus indicating the formation of mixed polynuclear complexes. (tr-auth)

6131 THE FUNCTION OF $K_2S_2O_8$ AS A POLYMERIZATION INHIBITOR IN MIXTURES OF H_2SO_4 AND 2-BUTANOL OR 2-BUTENE. Clark, George Stuart. Orono, Maine, Univ. of Maine. 251p.

Thesis.

The formation and reactions of sec-butyl hydrogen sulfate in H_2SO_4 and D_2SO_4 at 0°C was investigated. Either 2-butanol or 2-butene will dissolve in 98% H_2SO_4 (mole ratio 1 : 5) to form a stable equilibrium mixture of sec-butyl alkoxonium ion and sec-butyl hydrogen sulfate if small amounts of $K_2S_2O_8$ are present. In the absence of $K_2S_2O_8$ polymerization rapidly occurs, producing an acid-insoluble fraction which is mostly saturated hydrocarbons and an acid-soluble fraction consisting of alkyl-substituted cyclopentenyl cations. The role of $K_2S_2O_8$ as a polymerization inhibitor is shown to be that of a scavenger of the traces of 2-butene in the system, thus blocking the initial step of the polymerization reaction, which is the addition of sec-butyl cation to butene. That sec-butyl cations are present in the system is shown by experiments with hydride donors such as methylcyclopentane, in which n-butane is evolved in appreciable quantities. The saturated polymers obtained from these systems were also found to participate in a hydride exchange reaction with the sec-butyl cation. In experiments with D_2SO_4, the hydrogen-deuterium exchange of the sec-butyl groups of the ester occurs even in the presence of $K_2S_2O_8$ to lend support to the hypothesis of a π-complex as a necessary intermediate between the alkyl cation and alkene. The acid-insoluble hydrocarbon polymers obtained from these systems are not completely saturated as previously claimed but contain significant amounts of unsaturation. These unsaturated species appear to be alkyl-substituted olefins containing 14 or more carbon atoms per molecule, and participate intimately in the polymerization reaction of 2-butanol and 2-butene. The fractions of polymer containing these species promote the polymerization of systems which have been stabilized by $K_2S_2O_8$. (Disser. Abstr.)

6132 VALENCES OF EUROPIUM AND YTTERBIUM IN COMPOUNDS. Gschneidner, K. A. Jr. (Ames Lab., Iowa). J. Less-Common Metals, 17: 13-24(Jan. 1969).

Europium and ytterbium are the only lanthanide metals that are divalent in their standard state. In some of their compounds these two metals are trivalent, e.g., the sesquioxides and trihalides. In order to form compounds in which europium and ytterbium are trivalent, the extra 4f electron in the pure metals must be promoted to a valence or outer electronic level. The energy of promotion is calculated to be 23 and 9 kcal/g at Eu and Yb, respectively. It is this energy of promotion that plays a decisive role in determining the valence state assumed by europium and ytterbium in their compounds. From the magnitudes of these values it is seen why there are more compounds in which ytterbium is trivalent than europium. The relationship between the location of the nonlanthanide element partner in the Periodic Table and the valence state of europium and ytterbium in the various compounds is discussed. (auth)

6133 THERMODYNAMICS OF IONIZATION OF DEUTERIUM OXIDE. Goldberg, Robert N.; Hepler, Loren G. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem., 72: 4654-9(Dec. 1968).

Heats of neutralization of HCl (in H_2O) with NaOH (in H_2O) and of DCl (in D_2O) with NaOD (in D_2O) were measured calorimetrically. Heats of dilution of NaOD (in D_2O) were also measured. Results of these measurements were combined with other heat of dilution data to yield standard heats of ionization of H_2O and D_2O at 298°K. The results are ΔH^0 = 13,350 cal/mol for H_2O and ΔH^0 = 14,488 cal/mol for D_2O. This ΔH^0 for H_2O is in excellent agreement with results of several other calorimetric investigations but is smaller than a value derived from the variation of the ionization constant of H_2O with temperature. Our calorimetric ΔH^0 for D_2O is larger than the value derived from variation of the ionization constant of D_2O with temperature. Standard states and concentration scales for aqueous solutions are discussed, followed by calculation of free energies and entropies of ionization of H_2O and D_2O. (auth)

6134 COMPOSITION OF URANIUM OXIDES HEATED IN THE AIR. Goto, Kunihiro (Showa Electrochemical Industrial, Ltd., Japan). Nippon Kagaku Zasshi, 89: 927-9(Oct, 1968). (In Japanese).

Uranium oxide powder was heated at various temperature in air and the atomic ratio O/U in the equilibrium state was determined. The composition of U_3O_{8-z} in the air depends on the temperature and they are $UO_{2.460}$ at 650°C, $UO_{2.453}$ at 800°C, and $UO_{2.445}$ at 1000°C. When samples of uranium oxide are heated at 1000°C in the air, they suffer an irreversible loss in weight. The irreversible weight loss observed after heating for 100 hr is approximately 0.02% of the total weight. After being reduced in the hydrogen atmosphere, the equilibrium composition can be easily reached by heating in the air. (NSA of Japan)

6135 DEUTERIUM ISOTOPE EFFECTS ON THE SPECTROSCOPIC PROPERTIES OF TERBIUM AND EUROPIUM DIBENZOYLMETHIDE CHELATES. Mikula, James Julius. Philadelphia, Temple Univ., 1968. 154p.

Thesis.

The intensity of luminescence of piperidinium tetrakis (1,3-diphenyl-1,3-propanediono) Tb(III) in EPA is enhanced when the phenyl groups are deuterated. This luminescence was measured as a function of temperature, and the enhancement appeared to be constant over the temperature range studied. Similar studies when carried out with piperidinium tetrakis (1,3-diphenyl-1,3-propanediono) Eu(III) with deuterated phenyl groups did not lead to any appreciable enhancement over that of the undeuterated complex. Deuterated and protonated tris dibenzoylmethides of Eu(III) and Tb(III) displayed the same behavior as the tetrakis chelates. Increased ion emission was observed with the deuterated Tb complex but not with the deuterated Eu complex. Substitution of D for H on the benzene rings of dibenzoylmethide rare earth chelates has no appreciable effect on radiationless quenching from the ion level directly to the ground state in the temperature region studied. Quenching through C – H vibrations on the benzene ring does not appear to be important in EPA solutions of these compounds. The temperature dependence of emission as well as the difference observed between Tb and Eu complexes upon deuteration is explained in terms of quenching of the ion emitting level through thermal population of the energy level immediately above. In Eu dibenzoylmethides this is the ionic $^5D_1$ level which was found to be unaffected by deuteration of the ligand. Since the energy separation between the two ion levels remains constant the degree of quenching by this path is unaltered and no change in emission intensity from Eu results. On the other hand, for terbium dibenzoylmethide chelates, the level that becomes thermally populated is the lowest triplet which is slightly raised in energy upon deuteration of the ligand. Thermal quenching through the triplet is thereby lessened and as a result the intensity of emission obtained from the deuterated terbium chelate is greater than that of the protonated chelate. A model is proposed which fits the variation of luminescence intensity with temperature at least in the case of the terbium chelate. (Disser. Abstr.)

6136 KINETICS AND MECHANISMS OF SOME RAPID SUBSTITUTION AND OXIDATION-REDUCTION REACTIONS OF IRON (III), EUROPIUM(II), AND CHROMIUM(II) IONS. Carlyle, David Wesley. Contract W-7405-eng-82. Ames, Iowa, Iowa State Univ, 1968. 189p. (IS-T-232).

Thesis.

Kinetic and equilibrium properties of substitution reactions of halo and pseudohaloiron(III) complexes were measured in acidic aqueous solution. Evidence was obtained for the existence of the ion pair $Fe^{3+} \cdot Br^-$ as well as for the inner complex $FeBr^{2+}$. The equilibrium constant for formation of each complex from Fe^{3+} and Br^- was separately measured at 1.6°, and 1.00M ionic strength; the values are Q^0_{Br} = 0.20 M^{-1} and Q^1_{Br} = 0.034 M^{-1}. The equilibrium constants measured for formation of the complexes FeF^{2+}, FeN_3^{2+}, and $FeNCO^{2+}$ from Fe^{3+} and the protonated anions under the same conditions were 166, 0.364, and 11.8, respectively. The rate of aquation of FeN_3^{2+} was studied as a function of temperature and acidity. The rate of reduction of Fe(III) by Eu^{2+} and by Cr^{2+} in perchlorate solution was studied as a function of temperature and acidity. The rate laws were each of the form $-d[Fe^{3+}]/dt = (k_1 + k_2/[H^+])[Fe^{3+}][M^{2+}]$. The measured values of the rate constants were k_1 = 3410 and 250 M^{-1} sec^{-1}; k_2 = 2280 and 800 sec^{-1} for Eu^{2+} and Cr^{2+} respectively, at 1.6° and 1.00M ionic strength. Two additional rate terms for reduction of Fe(III) were found when halide or pseudohalide ions (X^-) were present. The rate terms were described by the following expressions: $-d[FeX^{2+}]/dt = k_{FeX}[FeX^{2+}][M(II)]$ and $-d[Fe(III)]/dt = k_X[Fe(III)][M(II)][X^-]$. The k_{FeX} and k_X terms represent reduction of the inner complex FeX^{2+}, and halide catalyzed reduction of Fe(III) not proceeding through FeX^{2+} formation, respectively. Typical values for the rate constants are $k_{FeCl} = 2 \times 10^6$ M^{-1} sec^{-1} and $k_{Cl} = 6 \times 10^3$ M^{-2} sec^{-1} at 1.6° and 1.00M ionic strength, for oxidation of Eu(II). The substitution reactions of iron(III) were discussed in terms of the limiting rate of replacement of water in $Fe(H_2O)_6^{3+}$ and $Fe(H_2O)_5OH^{2+}$. The oxidation-reduction reactions were discussed in terms of inner

sphere mechanisms. Inner sphere mechanisms were directly verified for Cr(II) reductions and were indirectly inferred for Eu(II) reductions. (Disser. Abstr.)

6137 DETERMINATION OF THE COMPOSITION OF RARE EARTH COMPLEXES WITH 7-IODINE-8-HYDROXYQUINOLINE-5-SULFOACID. Gromova, M. I.; Romantseva, T. I.; Peshkova, V. M. Vestn. Mosk. Univ., Ser. II. Khim., No. 5, 100-2(Sept.-Oct. 1968). (In Russian).

Neodymium and erbium complexing with 7-iodo-8-hydroxy-5-quinolinesulfonic acid at pH 6.0 ± 0.1 and ionic strength 0.1 was studied. 7-Iodo-8-hydroxy-5-quinolinesulfonic acid was found to react with neodymium and erbium in the ratio of 1:1. (auth)

6138 NEW COMPOUND: $Th_2U_2O_9$. Rachev, V. V.; Kovba, L. M.; Ippolitova, E. A.; Abramova, L. A. (Moscow State Univ.). Neorg. Mater., 4: 475-6(Mar. 1968). (In Russian).

The formation of a binary oxide system of fluorite phases of $(Th,U)O_{2+x}$ with the ordered distribution of U, Th, and excess oxygen was studied. The results of the x-ray phase analysis of the ThO_2, $UO_{2.62}$, U_3O_8, and UO_3 mixtures annealed at 1150°C for 75 and 300 hr are described for the fluorite phase. Tabulated data are included on the phase compositions of the annealed products, lattice parameters of fluorite phases, and indexed roentgengram of $Th_2U_2O_9$ (at CuK_α emission and t = 20°C). (R.V.J.)

6139 THIOCYANATO COMPLEX OF TECHNETIUM. Schwoehau, K.; Pieper, H. H. (Kerforschungsanlage, Juelich, Ger.). Inorg. Nucl. Chem. Lett., 4: 711-13(Dec. 1968). (In German).

Two different methods of preparation yielded a mixture of thiocyanatotechnetates, precipitable as tetramethylammonium salts. Isolation of the violet complex, already much used in Tc spectrophotometry, showed on analysis that the complex ion is $[Tc(NCS)_6]^-$, confirmed by susceptibility measurements. Spectroscopic properties of the tetramethylammonium salt also indicate coordination of N, but not O. Solubility and absorption properties are described. (UK)

6140 VIBRATIONAL EXCITON STRUCTURE IN CRYSTALS OF ISOTOPIC BENZENES. Bernstein, Elliot R.; Robinson, G. Wilse (California Inst. of Tech., Pasadena). J. Chem. Phys., 49: 4962-72(Dec. 1, 1968).

New high-resolution infrared spectra of crystalline isotopic benzenes C_6H_6, C_6H_5D, p-, m-$C_6H_4D_2$, sym-$C_6H_3D_3$, and C_6D_6 are presented. Using these data in conjunction with isotopic mixed-crystal data and the polarized single-crystal spectra (C_6H_6) of Zwerdling and Halford, the exciton band structures and coupling constants for nondegenerate vibrations of C_6H_6 and C_6D_6 are obtained. One vibration of sym-$C_6H_3D_3$ was also analyzed. It is assumed that when the band shapes and splittings are nearly identical, the polarizations can be carried over from the C_6H_6 crystal to C_6D_6 and sym-$C_6H_3D_3$ crystals. It is not possible to analyze completely the degenerate bands of these isotopes since experimental data do not yield values of all the independent matrix elements appearing in the expression for the energy of the exciton components. In the isotopic modifications of lower symmetry, exciton structure is not easily interpreted due to an orientational effect, crystal induced Fermi resonance, and the inevitable presence of isotopic impurities. (auth)

6141 THERMAL DIFFUSION IN POLYATOMIC GASES: ISOTOPIC $^{15}N_2$–$^{14}N_2$. Raman, S.; Mathur, B. P.; Howard, A. J.; Champlin, J. W.; Watson, W. W. (Yale Univ., New Haven). Contract AT(30-1)-2726. J. Chem. Phys., 49: 4877-9(Dec. 1, 1968).

The thermal diffusion factor, α_T, for the isotopic gas-mixture $^{15}N_2$–$^{14}N_2$ was measured as a function of temperature in the range 100 to 740°K, using a ten-tube, stainless-steel trennschaukel. α_T values are negative below 130°K and at higher temperatures have the practically constant value 0.36 within the experimental uncertainties. Monatomic gas theory as developed by Chapman and Enskog is unable to explain the results for any realistic potential model. The dimensional treatment of Waldman is also ineffective. Internal consistency and the agreement with the data of other workers suggest a rather dominant effect of the internal degrees of freedom and inelastic collisions on thermal diffusion in polyatomic gases. (auth)

6142 ELECTRONIC STRUCTURE OF IONIZED MOLECULES. VII. ETHYLENE. Lorquet, A. J.; Lorquet, J. C. (Univ., Liege). J. Chem. Phys., 49: 4955-61(Dec. 1, 1968).

The potential-energy surfaces of the neutral C_2H_4 molecule and its positive ion were studied, and parts of them were calculated point by point by a semiempirical self-consistent method (SCF CNDO/2 with slight modifications). The calculations show that (1) the equilibrium configuration of the $C_2H_4^+$ ion is twisted (D_2 symmetry group). The potential function corresponding to the twisting motion has a double minimum and is remarkably flat. The vibrational structure observed in the different Rydberg states of C_2H_4 and C_2D_4 can be fitted to such a potential function. Values for the angle of twist and the potential barriers were proposed. (2) The exchange phenomenon occurring among hydrogen atoms (scrambling) in the ion takes place through the asymmetrical configuration CH_3CH^+. (auth)

6143 ELECTRON-MICROSCOPIC INVESTIGATION OF THE REACTION OF WATER VAPOR WITH SINGLE CRYSTALS OF GRAPHITE. I. REACTION WITH EDGE ATOMS. Montet, G. L.; Myers, G. E. (Argonne National Lab., Ill.). Carbon, 6: 627-36(Oct. 1968).

An experimental investigation of the initial stages of the reaction of highly purified single crystals of graphite with water vapor in helium at high temperatures is described. Water vapor concentrations ranged from 250 to 22,000 vpm (ppM by volume) and reaction temperatures ranged from 850 to 1075°C. Rates of reaction were determined by measuring the rates of increase in diameters of etch pits produced from lattice vacancies in cleaved surfaces of the crystals; the etch pits were decorated with gold to make them visible in an electron microscope. This technique limited the temperature range over which the reaction could be studied at any given concentration, but, in general, an interval of more than one hundred degrees could be covered. The apparent activation energy of the reaction varied with water vapor concentration, increasing steadily from 68 kcal-mole^{-1} at 22,000 vpm to 109 kcal-mole^{-1} at 250 vpm. The apparent order of the reaction, with respect to water vapor concentration, was 0.89 at all temperatures studied and appeared to be concentration independent in the range 500 to 22,000 vpm; there were indications, however, that a higher order may prevail at lower concentration. (auth) (UK)

6144 OXIDATION OF BORONATED GRAPHITE. Woodley, R. E. (Battelle Memorial Inst., Richland, Wash.). Carbon, 6: 617-26(Oct. 1968).

The oxidation of boronated graphite occurs by two competing reactions in the temperature range 580 to 780°C, namely, the oxidation of carbon to yield CO_2 and the oxidation of B_4C to yield B_2O_3 and CO_2. The former reaction is appreciably faster than the latter. The formation of molten B_2O_3 yields a physical barrier to reactant diffusion and, in the case of grey boronated graphite, leads to a maximum in the rate as a function of time. Because less B_2O_3 is formed in black boronated graphite, it behaves much like ordinary nuclear graphite. Upon removal of the B_2O_3 by leaching in boiling water, the oxidation rate is appreciably increased. This is particularly true for the grey boronated graphite, because the amount of B_2O_3 formed is greater than in black boronated graphite where the B_4C is apparently not as accessible to the oxidant. (auth) (UK)

6145 THE SOLUBILITY OF WATER VAPOR IN ZrO_2–Y_2O_3 MIXED CYRSTALS. Wagner, Carl (Max-Planck-Institut fuer Physikalische Chemie, Goettingen, Ger.). Ber. Bunsenges. Phys. Chem., 72: 778-81(Nov. 1968). (In German).

The solubility of H_2O in $ZrO_2-Y_2O_3$ solid solutions was determined at 900 to 1000°C. In accord with a previously suggested model, the solubility is proportional to the square root of the H_2O partial pressure. In addition, the diffusivity of interstitial protons in $ZrO_2-Y_2O_3$ solid solutions was determined. (auth)

6146 POLAROGRAPHIC BEHAVIOR OF THORIUM COMPOUNDS IN 1,2-PROPANEDIOL CARBONATE AND N,N-DIMETHYLACETAMIDE. Gutmann, V.; Bildstein, H.; Fleischer, H. (Technische Hochschule, Vienna. Oesterreichische Studiengesellschaft fuer Atomenergie, Seibersdorf, Austria). Monatsh. Chem., 99: 1680-5(Sept.-Oct. 1968). (In German).

Anhydrous and hydrated thorium compounds were investigated polarographically in both 1,2-propanediol carbonate and N,N-dimethylacetamide. The half-wave potentials (vs. aqueous saturated calomel electrode), the nature of the limiting currents, the analytical applicability of the waves, and the influence of water are described. (auth)

Radiation and Nuclear Chemistry

Refer also to abstracts 6744 and 7102.

6147 (COO-38-643) BIBLIOGRAPHY ON THE RADIATION CHEMISTRY OF ALCOHOLS AND PHENOLS. (Notre Dame Univ., Ind. Radiation Lab.). Nov. 8, 1968. Contract AT(11-1)-38. 34p. Dep. CFSTI.

References covering the literature from 1953 to 1968 are presented in categories (aliphatic alcohols, other alcohols, phenols,

and catalytic processes in alcohols) by serial number, which is approximately chronological. Author and compound indexes are included. (M.C.G.)

6148 (NP–17663) STUDY OF URANOUS NITRATE AS A REDUCER OF PLUTONIUM. IIb. EFFECT OF RADIATION ON THE STABILITY OF U(IV). Salomon, L.; Lopez-Menchero, E. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Mar. 1966. 40p. (In French). (ETR–182). Dep.

This report is a complement to ETR-181 on the stability of U(IV) in solution and treats particularly problems on the radiolytic stability. By taking account of the mean activity of U – Pu partition units and the residence time of the solutions in these units, it was verified that the stability of U(IV) is not sensibly affected by α, β, or γ activities in these conditions. The possibility of completely reoxidizing U(IV) traces contained in an organic phase by means of uv radiation was also studied. (tr-auth)

6149 IONIZING RADIATION EFFECTS ON VARIOUS TYPES OF STYRENE–DIVINYLBENZENE ION EXCHANGE RESINS. Pesek, Miroslav (Inst. for Research, Production, and Application of Radioisotopes, Prague). Jad. Energ., 14: 313-20(1968). (In Czech).

On the basis of investigations of the changes of exchange capacity, weight, swelling capacity, as well as of the influence of the composition of water extract from irradiated ion exchange resins, and changes in exchange rate and mechanical stability after ^{60}Co-gamma irradiation, an explanation of the decomposition mechanism of strongly basic anion exchange resins of the trimethylammonium-type and of strongly acidic cation exchange resins with $-SO_3H$ group based on styrene–divinylbenzene under the influence of high energy radiation is proposed. In the case of both types of ion exchange resins the decomposition occurs mainly due to direct effect of ionizing radiation. The destruction of the strongly basic anion resin of the trimethylammonium-type occurs mainly in the vicinity of the functional group and the macromolecular skeleton remains practically undistorted, whereas in the case of strongly acidic sulfocation exchangers of the styrene–divinylbenzene-type the functional groups as well to a great measure the macromolecular skeleton are decomposed. (auth)

6150 EFFECTS OF SCAVENGERS ON THE RADIOLYTIC FORMATION OF BUTA-1,3-DIENE FROM trans-BUT-2-ENE IN DILUTE GASEOUS MIXTURES. Hummel, R. W. (United Kingdom Atomic Energy Authority, Wantage, Eng.). Chem. Commun., No. 23, 1518-19(1968).

In previous work 1,3-butadiene was not listed as a radiolysis product of either liquid or gaseous butene. The present study found that the diene is produced in irradiated pure gaseous 2-butene (G = 0.13) and in its mixtures with Ar or CH_4. It was also found that the yield was markedly increased by small additions of N_2O, but reduced to zero by small additions of SF_6. Irradiation was ^{60}Co γ at dose rates of 2 and 1.5×10^{19} eV/1/hr, temperature 30°C. Results and mechanisms are discussed on the assumption that an important mode for butadiene formation is the neutralisation of the 2-butene parent ion by a thermal electron. It appears that a reaction scheme involving negative hydrocarbon ions can account for the effects of N_2O and SF_6 in this system. (UK)

6151 INTERACTION OF HYDROGEN ATOMS WITH ALKALI METAL IONS. Bloom, M. B. D.; Eachus, R. S.; Symons, M. C. R. (Univ. of Leicester, Eng.). Chem. Commun., No. 23, 1495-6(1968).

A novel interaction between a H-atom and a Na-ion is reported which was observed during ESR studies of irradiated polycrystalline $BaSO_4$. Gamma irradiation of precipitated $BaSO_4$ containing trace amounts of water led to the formation of H-atoms which were subsequently trapped at specific lattice sites. When the $BaSO_4$ was precipitated from solutions containing Na-ions the ESR powder spectrum of the irradiated vacuum dried sample indicated the presence of two non-equivalent hydrogen species. The more abundant species had spin resonance parameters similar to those of H-atoms in the gas phase, while the second species, characterised by a pair of quartets separated by ~500 G, was interpreted in terms of an interaction between a H-atom and a single Na-ion. When K-ions were incorporated into the lattice, the analogous $K^+ \ldots H$ species was formed on irradiation, while precipitation from D_2O resulted in formation of the corresponding $Na^+ \ldots D$ radical. Mechanisms are discussed. (UK)

6152 EFFECTS OF STRUCTURE OF MACROMOLECULES OF SULFOCATIONITES ON THEIR RADIATION STABILITY. Tulunov, P. E.; Kasperovich, A. N. Zh. Fiz. Khim., 42: 1978-82 (Aug. 1968). (In Russian).

Studies were made on the radiation stability of a series of condensation sulfocationites on a base of aromatic compounds with condensed nuclei (anthracene, phenanthrene, acenaphthene, and pyrene) and also of the polymerization sulfocationite KU-3A on a base of α-vinylnaphthalene. It was found that the radiation stability of the condensation cation exchangers depended very little on the nature of the monomers but it was significantly above that of the polymerization resins KU-3A. The cation exchangers KU-3A and KU-2 had equal stability. It was assumed that the small differences of resistance to irradiation by condensation cation exchangers is a result of the ratio of the quantity of sulfo groups in the α and β positions in the condensed aromatic nuclei. In contrast to all of the other cation exchangers during irradiation of resin KU-3A, the process of desulfurization proceeded much more rapidly than the inactivation of sulfo groups. (tr-auth)

6153 STABLE ISOTOPES: SALES AND LOANS OF ISOTOPIC SAMPLES, NUCLEAR TARGETS, ISOTOPIC FOILS, AND MOESSBAUER ADSORBERS. Harwell, England, Atomic Energy Research Establishment, 1968. 28p.

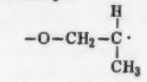
Details are given, with costs, of the availability of these materials. Notes are included on ordering procedure, payment, and delivery. Information is also given on target preparation. (UK)

6154 EFFECT OF HEAT-TREATMENT AND UV-IRRADIATION ON X-RAY INDUCED ELECTRON SPIN RESONANCE CENTERS IN VALINE. Schnepel, G. H.; Moenig, H. (Univ., Freiburg i. B.). Experientia, 24: 1113-14(Nov. 15, 1968).

In the ESR spectra of x-irradiated polycrystalline valine at room temperature the hyperfine structure is not resolved. A well resolved hyperfine structure was obtained after warming the irradiated valine to 353°K. Irradiation of x-irradiated valine with uv radiation leads to a similar result. (M.C.G.)

6155 ELECTRON SPIN RESONANCE STUDY OF POLYGLYCOLS. Thryion, F. C.; Baijal, M. D. (Laval Univ., Quebec). J. Polym. Sci., Part A-1, 6: 505-11(Mar. 1968).

Polyethylene glycols and polypropylene glycols were irradiated with gamma rays from a ^{60}Co source at 77°K. Electron spin resonance spectra of the free radicals produced were recorded. It was found that the rupture in the polymer chain takes place at °C–C and C–O bonds. The radicals identified were $-O-CH_2$ in polyethylene glycols and mainly



in polypropylene glycols. Thermal decay of these radicals followed a second-order law, and the decay constant calculated was k = 2.32×10^5 cm^3 mole^{-1} sec^{-1}. A complete discussion of the results is presented. (auth)

6156 DIRECT DETERMINATION OF CROSSLINKING AND CHAIN SCISSION IN POLYMERS. Kells, D. I. C.; Koike, M.; Guillet, J. E. (Univ. of Toronto). J. Polym. Sci., Part A-1, 6: 595-601(Mar. 1968).

A direct method has been developed for determining G(crosslinks) for irradiated polymers using the analytical ultracentrifuge. The sedimentation velocity technique is employed to follow changes in the molecular weight of a narrow distribution polystyrene sample irradiated in vacuum with ^{60}Co γ rays. It was found that G (crosslinks) can be determined at low doses before significant structural changes have occurred in the polymer. At about one-fifth of the gel dose G(crosslinks) was found to be 0.019 compared to a value of 0.040 obtained from gel-sol fraction measurements. It was concluded that G(crosslinks) may increase with dose due to processes such as the addition of radicals to double bonds formed during the irradiation. (auth)

6157 KINETICS OF THE γ-RADIATION-INDUCED POLYMERIZATION OF ETHYLENE IN LIQUID CARBON DIOXIDE. Hagiwara, Miyuki; Mitsui, Hiroshi; Machi, Sueo; Kagiya, Tsutomu (Japan Atomic Energy Research Inst., Gunma). J. Polym. Sci., Part A-1, 6: 609-21(Mar. 1968).

The γ-radioinduced polymerization of ethylene with the use of liquid carbon dioxide as a solvent, was studied from the viewpoint of kinetics. The polymerization was carried out at conversions less than 10% under the pressures ranging from 100 to 400 kg/cm^2, dose rates 1.3×10^4 to 1.6×10^5 rad/hr, and temperatures of 20 to 90°C. The concentration of carbon dioxide varied up to 84.1 mole-%. The polymerization rate and the polymer molecular weight were observed to increase with reaction time. This observation, however, became less pronounced with increasing concentration of carbon dioxide and with rising temperature. The exponents of the pressure and the dose rate were determined to be 2.3 and 0.85 for the rate, and 2.0 and –0.20 for the molecular weight, respectively. From the kinetic considerations for these results, the effects of carbon dioxide on the initiation and termination reaction in the polymerization were evaluated. (auth)

6158 RADIOCHEMICAL AND PHOTOCHEMICAL STUDIES AT THE INSTITUT FUER RADIUMFORSCHUNG UND KERNPHYSIK. I. Getoff, N. Oesterr. Akad. Wiss., Math.-Naturwiss. Kl., Sitzungsber. Abt. II, 176: 253-88(1968). (In German).

A review is presented of radiochemical and photochemical studies including the solvated electron, reactivity of the excited water molecule, formation of organic materials from CO_2 and water, carboxylation of organic substances, carbonylation of organic material, radiochemical and photochemical introduction of sulfur and phosphorus into organic materials, radiochemical and photochemical ammonia formation from N_2 and H_2O, radiochemical and photochemical introduction of nitrogen into organic materials, hydrazine formation in aqueous solution under the effect of uv light and γ radiation, radiochemical and photochemical formation of amino acids, radiochemical introduction of NO into organic substances, electron spin resonance studies, and pulse radiolysis. (104 references) (J.S.R.)

6159 CHEMICAL ANALYSIS OF DNA ALTERATIONS. III. ISOLATION AND CHARACTERIZATION OF ADENINE OXIDATION PRODUCTS OBTAINED FROM OLIGO- AND MONODEOXYADENYLIC ACIDS TREATED WITH HYDROXYL RADICALS. Rhaese, Hans-Jurgen Public Health Service, Bethesda, Md.). Biochim. Biophys. Acta, 166: 311-26(Sept. 24, 1968).

Oligo- and monodeoxyadenylic acid as well as adenosine and adenine are oxidized by H_2O_2 at concentrations less than 0.1M and at a pH of 7.4 at the N-7 position of the base moiety leading to adenine-7-N-oxide derivatives. At H_2O_2 concentrations higher than 0.1M and at pH 8.0 two additional products are formed, which have been identified as 8-hydroxy- and 2-hydroxyadenine. The production, isolation, and the methods leading to the chemical characterization of these products are described. Adenine-7-N-oxide was found to be sensitive to ultraviolet light, yielding adenine and 8-hydroxyadenine. The 7-N-oxide of dAMP, whose production and isolation from dAMP is also described, is as stable against 1M HCl or NaOH as dAMP itself. The oxidation of dAMP to the 7-N-oxide and the liberation of adenine-7-N-oxide from the deoxynucleotide are two independent reactions, as is shown kinetically. Adenine-7-N-oxide was found to be among the reaction products of x-irradiated aqueous solutions of adenine representing the effect of OH radicals. The three oxidation products, being base analogs, were tested for their ability to induce point mutations in the phage T4. All three were found not to be mutagenic base analogs in the test system which, however, does not rule out their significance for the induction of mutations when formed within the DNA of a multiplying organism. 7-Methyl- and 7-ethylguanine have also been shown not to induce revertants in phage T4 mutants when added to the growth media, yet they are believed to be responsible for the point mutagenic effect of methyl- and ethylmethanesulfonate, respectively. (auth)

6160 LIQUID CARBON DIOXIDE AS A SOLVENT FOR THE RADIATION POLYMERIZATION OF ETHYLENE. Hagiwara, Miyuki; Mitsui, Hiroshi; Machi, Sueo; Kagiya, Tsutomu. (Japan Atomic Energy Research Inst., Gunma). J. Polym. Sci., Part A-1, 603-8(Mar. 1968).

The usefulness of liquid carbon dioxide as a solvent for polymerization of ethylene was studied. The effects of liquid carbon dioxide on the polymerization was investigated under conditions of the pressure of 400 kg/cm^2 over the temperature range 20 to 45°C by using γ radiation and azobisisobutyronitrile (AIBN) as initiators. The infrared spectrum of the polymers showed that carbon dioxide had little effect on the polymer structure. The polymers contained no combined carbon dioxide and only small amounts of vinylidene unsaturation. The methyl content of the polymers was 0.5 to 4.0 CH_3/1000°C. The polymer yield and molecular weight were found to be decreased by the addition of carbon dioxide in both polymerization by γ radiation and AIBN. The number of polymer molecules formed per unit time increased with the content of carbon dioxide in the γ-ray polymerization, and was constant in the case of AIBN. The advantages of the use of liquid carbon dioxide as a solvent in this polymerization were also considered from the viewpoints of the continuous process, the separation of polymer, the stability of carbon dioxide to radiation, and commercial applications. (auth)

6161 AN ELECTRON SPIN RESONANCE STUDY OF TROPENYL AND MONODEUTEROTROPENYL RADICALS. Volland, Walter Victor. Pullman, Wash., Univ. of Washington, 1967. 282p.

Thesis.

Tropenyl radical, $C_7H_7\cdot$, and monodeuterotropenyl radical, $C_7H_6D\cdot$, were studied by ESR spectroscopy. In these experiments the four areas of major interest were the study of the effect of the deuteron substituent in $C_7H_6D\cdot$ on the orbital degeneracy of the radical, analysis of the asymmetric spectrum of $C_7H_7\cdot$ in polycrystalline perdeuteronaphthalene ($C_{10}D_8$), evaluation of the enthalpy of dissociation of bitropenyl and estimation of the total empirical resonance energy of the $C_7H_7\cdot$ radical. Monodeuterotropenyl radical was generated by thermal cleavage of $(C_7H_6D)_2$. A study of the spectrum as a function of temperature was used to estimate an upper limit for the energy separation between the nearly degenerate molecular orbitals of the radical. It was estimated that this energy separation has an upper limit of 20 cal/mole. The $C_7H_6D\cdot$ proton and deuteron hyperfine splittings were observed to be temperature dependent. Tropenyl radical was generated by means of x-ray damage to cycloheptatriene (C_7H_8) in polycrystalline $C_{10}D_8$. The ESR spectrum of tropenyl radical in this matrix consists of eight non-overlapping components with polycrystalline line shapes. At 0°C the isotropic splitting, which is temperature dependent, has a value of -3.892 ± 0.007 G, where the sign of the splitting was assigned on the basis of theory. Values of the components of the g tensor were measured for $C_7H_7\cdot$ in $C_{10}D_8$. The average of the x and y components of the tensor, $g_\perp$, is 2.00294 ± 0.00001. The value of $g_{||}$, the z component of the tensor, is 2.00240 ± 0.00005. The enthalpy of dissociation, ΔH_{dis}, of 7,7′-bitropenyl was determined by measurement of the relative intensity of the $C_7H_7\cdot$ spectrum in solution as a function of temperature. The value is $+34.8 \pm 0.5$ kcal/mole. Using the value of ΔH°_{dis}, the total empirical resonance energy of $C_7H_7\cdot$ was estimated to be 26.4 kcal/mole. The total delocalization energy was estimated for the seven π electrons in $C_7H_7\cdot$ and is 39.8 kcal/mole. A study was made of the rate of intramolecular thermal isomerization of 7,7′-bitropenyl. Rate constants, ranging from $(6.56 \pm 2.20)10^{-6}$ sec^{-1} at 410°K to $(4.37 \pm 0.58)10^{-4}$ sec^{-1} at 460°K, were determined for this first-order reaction from the rate of decay of the ESR signal of $C_7H_7\cdot$ in equilibrium with bitropenyl. The concentration of $C_7H_7\cdot$ in liquid bitropenyl was measured for samples at 406 and 430°K. The equilibrium constant, 2×10^{-13} M at 406°K, for the thermal dissociation was estimated from the measured radical concentration. As a part of the determination of the tropenyl radical concentration, the line shape of the hyperfine components was analyzed and was found to be approximately Lorentzian. (Diss. Abstr.)

6162 IMPURITIES IN ^{64}Cu PRODUCED BY (n,γ) REACTION. Nakamura, Haruto; Yamabayashi, Hisamichi (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 10: 550-3(Oct. 1968). (In Japanese).

In order to produce high-purity radioisotopes by (n,γ) reactions it is important to use highly pure target materials. Elimination of the impurities after irradiation is not practical when producing isotopes of short half-life, because the specific activities would decrease during the time required for the process. The purities of standard reagent grade Cu from two production forms were compared by activation analysis without any radiochemical separation. The purer of the two was selected, and the impurities in it were determined accurately by activation analysis with radiochemical separation. Among the impurities found in the product nuclide, ^{65}Ni and ^{60}Co can derive from fast neutron reactions on the target material as well as from impurities originally contained in the target. It was confirmed by polarographic determination of Ni that the greater part of the ^{65}Ni activity detected was due to ^{65}Cu(n,p)^{65}Ni reaction. It was found that the purity of this target was high enough to produce 99.99% radiochemically pure ^{64}Cu isotope. (NSA of Japan)

6163 PHOTODIMERIZATION OF CYCLOHEXENONE AND RADIATION CHEMISTRY OF BENZOPHENONE IN CYLOHEXENE SOLUTION. Lam, Ernest Yee Yeung. Pasadena, Calif., California Inst. of Tech., 1968. 140p.

Thesis.

The photodimerization of cyclohexenone has been studied in the neat liquid and in solvents. Although four products can be detected, two predominate under all conditions. The reaction can be sensitized by benzophenone, thioxanthone, acetophenone, and naphthalene. The enone was used as a sensitizer for the cis-trans isomerization of three pairs of isomeric olefins and the response was used to estimate the triplet excitation energy of the enone as 61 ± 1 kcal/mole. Dimerization can be quenched by addition of piperylene. Most evidence points to a triplet mechanism for the reaction. However, the ratio of 1 to 2 varies with reaction conditions and the quantum yield does not show the expected variation with enone concentration. These phenomena are attributed to solvent effects, rather than to a change of mechanism. Gamma irradiation of benzophenone in cyclohexene solution produced 3,3′-dicyclohexenyl and cyclohexenyldiphenylcarbinol as main products. The reaction was quenched by phenyl disulfide and to a less extent by chloroform. It was not significantly affected by 2-propanol. Naphthalene also acted as a quencher. The reaction probably involved the cleavage of the allylic C–H bond of cyclohexene to a cyclohexenyl radical and a hydrogen atom. Benzophenone effectively took up the hydrogen atom to give a ketyl radical. The main

cross product, cyclohexenyldiphenylcarbinol, resulted from a combination of the ketyl radical with the cyclohexenyl radical. Quenching by naphthalene was taken to be an indication that excited states of cyclohexene played an important role, probably as a precursor of cyclohexenyl radical. This was supported by the fact that gamma irradiation or cis- or trans-2,3-diphenylpropenes in cyclohexene solution resulted in isomerization. That benzophenone did not act as an energy sink in cyclohexene was probably due to inefficient energy transfer from an excited cyclohexene triplet to benzophenone. (Disser. Abstr.)

6164 USE OF β-DECAY PROCESSES AS METHODS FOR OBTAINING AND STUDYING REACTIONS OF FREE CARBONIUM IONS, RADICALS, AND CARBENES. Nefedov, V. D.; Sinotova, E. N.; Akulov, G. P.; Syreishchikov, V. A. Radiokhimiya, 10: 600-3(1968). (In Russian).

Aspects of the β-decay method for producing and studying reactions of free carbonium ions of various composition, structure, and initial localization charge and studying ion-molecule reactions of direct formation of free carbonium ions with various types of molecules in gaseous, liquid, and solid phases are reviewed. Experiments were made with the reactions of free methyl carbonium ions formed by the β decay of tritium in methane composition in a gaseous phase with water, methanol, and ethanol under pressures of vapors of 20, 96, and 44 mm Hg, respectively, at room temperature; exposure time 10 days. The yields of ion-molecule reactions are tabulated. (R.V.J.)

6165 METHYL CATION REACTIONS DURING β DECAY OF TRITIUM IN METHANE AND CERTAIN HALIDE DERIVATIVES. Nefedov, V. D.; Sinotova, E. N.; Akulov, G. P. Radiokhimiya, 10: 609-10(1968). (In Russian).

Previous works considered the β-decay processes of tritium atoms and some halide isotopes in hydrocarbon and halide derivative composition in order to determine reactions of free carbonium ions, radicals, and carbenes. An attempt was made to study reactions of methyl cations produced by conversion during β decay of tritium with HCl, HBr, HI, C_2H_5Cl, C_2H_5Br, and C_2H_5I in gaseous phases. Chromatograms of reactions of methyl carbonium ions with molecules of ethyl chloride, ethyl bromide, and ethyl iodine are included. Data obtained show that the products of carbonium ions with C_2H_5Cl, C_2H_5Br, and C_2H_5I are the respective methyl halides with yields diminishing in transition from iodine to bromine and chlorine derivatives. In the case of ethyl chlorine and ethyl bromine other compounds were formed as follows: C_2H_5Cl, iso-C_3H_7Cl and n-C_3H_7Cl and C_2H_5Br and iso-C_3H_7Br, respectively. (R.V.J.)

6166 METHOD FOR PRODUCING POLYFLUOROCYCLOBUTENES WITH A DIALKYLPHOSPHONO GROUP. Inukai, Kagami (to Chief of the Agency of Industrial Science and Tech.). Japanese Patent 1968-5745. Mar. 2, 1968. Filed Nov. 26, 1965.

A simple and economical method is proposed for producing polyfluorocyclobutenes with a dialkylphosphono group. The compounds can be used as agricultural chemicals, surface active agents, high polymers, etc., and are obtained by irradiating mixtures of perfluorocyclobutene and dialkyl phosphite with high-energy radiation. (NSA of Japan)

6167 RADIOCHEMICAL PRODUCTION OF LEAD RADICALS FROM HEXAPHENYLDILEAD. Plato, Martin; Schnabel, Wolfram; Wendenburg, Juergen (AEG-Forschungsinstitut, Frankfurt am Main). Z. Naturforsch., 23b: 1260-1(Sept. 1968). (In German).

In the γ irradiation of polycrystalline hexaphenyldilead at $-192°C$ an EPR spectrum, consisting essentially of a line doublet, was obtained. The line with g = 1.9437 was assigned to a Pb radical and that with g = 2.0023 to a C radical. The concentration of the Pb radical increased with increasing Ph_6Pb_2 content of the MTHF glass and the concentration of the captured electrons decreased. With illumination or heating of the irradiated sample, the strength of the electron signal decreased and that of the Pb signal increased. The absorption band at 4740 Å was displaced toward 5600 Å with slight heating. (J.S.R.)

6168 TEN YEARS' PRODUCTION OF RADIOACTIVE NUCLIDES IN THE GERMAN DEMOCRATIC REPUBLIC. Muenze, R. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Isotopenpraxis, 4: 413-16(Nov. 1968). (In German).

The production of radioisotopes and labeled compounds is reviewed. Total production and part exported are given in Curies. (M.C.G.)

6169 RADIATION-INDUCED OXIDATION OF ISOOCTANE IN THE PRESENCE OF IONOL. Pospelov, V. E.; Saraeva, V. V.; Galkin, N. I. Vestn. Mosk. Univ., Ser. II. Khim., No. 5, 29-32 (Sept.-Oct. 1968). (In Russian).

The radioinduced oxidation of isooctane in the presence of an inhibitor (ionol) was studied. The yield of oxo-compounds was shown to drop to zero at sufficiently high ionol concentration. The yield of hydroperoxide increased to G = 1.3 and 1.5 at −78 and 0°C and decreased to G = 1.5 at +70°C. All the oxidation products were supposed to be formed from peroxyradicals. (auth)

6170 PULSE RADIOLYSIS STUDIES. Klein, Nathan. Newark, Del., Univ. of Delaware, 1967. 88p.

Thesis.

The objectives of an investigation of chemical reactions taking place in aqueous solutions during and immediately after an x-radiation pulse were first, to determine whether there existed a measurable period during which transient species, produced by the radiation, were inhomogeneously distributed in solution and, second, to shed light on the nature of the primary radiolytic species produced in aqueous solution by ionizing radiation. The techniques of kinetic spectroscopy were used to achieve these goals. Equipment was assembled that is capable of measuring optical absorption as a function of time using 6328 Å light. The resolving time of this equipment is in the nsec range. The hydrated electron, e^-_{aq}, was produced in solutions of Na_2CO_3, $Ba(OH)_2$, H_2SO_4, and $HClO_4$ by a 3 kRAD, 50 nsec, x-ray pulse from an electron accelerator. No evidence for nonhomogeneous distribution of e^-_{aq} was obtained. In air-free alkaline solution, an extremely rapid, second-order decay of the e^-_{aq} absorption was observed. This decay is observed for approximately $\frac{1}{2}$ μsec after an x-ray pulse. The rate-constant determined for this apparent second-order reaction, possibly the fastest ever observed in aqueous solution, is 3.2×10^{11} $M^{-1}sec^{-1}$. The reaction is not observed in acidic or air-saturated solution due to the extreme reactivity of e^-_{aq} with H^+ and O_2. It is proposed that the observed reaction of e^-_{aq} is with excited water, H_2O^*, and the excitation energy delocalized over a highly hydrogen-bonded water "cluster." The large size and very high mobility of such clusters coupled with the long range "structure-making" nature of e^-_{aq} may account for the extreme rapidity of the reaction observed. The testing of this hypothesis by addition of chemical inert "structure-breaking" ions is described. The excellent agreement between observation and prediction in these tests adds credence to the plausibility of the hypothesis. (Disser. Abstr.)

6171 RADIATION POLYMERIZATION OF TRIFLUOROACETALDEHYDE. Bird, Douglas. Akron, Ohio, Univ. of Ohio, 1967. 173p.

Thesis.

The radiation polymerization of trifluoroacetaldehyde (fluoral) was studied in the belief that this monomer, with carbonyl unsaturation and a highly electron-withdrawing substituent, would prove particularly susceptible to anionic attack. Experiments were generally carried out at −78°C with radiation dose rates in the range 0.5 to 0.7 Mrad/hour. Polymerizations in diethyl ether were very fast and were second-order in monomer, while comparable polymerizations in dichloromethane were about 100-fold slower and showed kinetics characteristic of bimolecular termination with solvent. Polymerizations in ether with radical traps such as benzoquinone and naphthalene were not significantly retarded and high levels of 2,2′-diphenylpicrylhydrazyl accelerated the reaction. On the other hand, $TiCl_4$ and $FeCl_3$ did retard the polymerization. These results provided strong evidence for a predominantly anionic propagation in the polymerization of this monomer. The dependence of polymerization rate on radiation dose rate was linear over the range 0.13 to 0.67 Mrad/hour, consistent with an ionic propagation, and these data, taken with measurements of the temperature coefficient of the reaction, support a proposed unimolecular termination in ether. Some experiments on the chemically-initiated polymerization of fluoral demonstrated that it was rapidly polymerized by very weak bases, such as the trifluoroacetate anion, and that a unimolecular termination again appeared to be operating. At −78°C radical and cationic polymerizations were found to be very much slower than those initiated by anions. (Disser. Abstr.)

6172 RADIATION-INDUCED SOLUTION POLYMERIZATION OF BIS(β-CHLOROETHYL) VINYLPHOSPHONATE. Fujii, Shigetada; Yamakita, Hiromi (Government Industrial Research Inst., Nagoya, Japan). Nippon Kogyo Gijutsu Shikensho Hokoku, 17: 113-19(May 1968). (In Japanese).

The γ-induced solution polymerization of bis(β-chloroethyl) vinylphosphonate (CEVP) in several kinds of organic solvents was carried out, and the reaction mechanism was studied. Polymerization within the temperature range from 40 to −78°C is considered to take place by a free radical mechanism. The dependence of the rate of solution polymerization (R_p) on the dose rate (I) both in dioxane and chloroform shows that the indexes of I increase with the concentration of the monomer, but that they do not differ much from 0.5 in a wide range of concentration. The chain trans-

fer constants to these two solvents from monomer are smaller than that to the monomer in the bulk polymerization of CEVP, though they are much larger than the values in the solution polymerization of ordinary vinyl monomers. A kinetic equation was derived from these results. Reaction mechanisms were studied by applying the experimental data to the equation. The rate of the solution polymerization was generally smaller than that of the bulk polymerization due to the energy transfer reaction from the monomer to the solvent. (NSA of Japan)

6173 RADIATION-INDUCED GAS-PHASE GRAFT COPOLYMERIZATION OF ALKYL METHACRYLATES ONTO POLYPROPYLENE FIBERS AND THERMAL PROPERTIES OF GRAFTED FIBERS. Kawase, Kaoru; Hayakawa, Kiyoshi (Government Industrial Research Inst., Nagoya, Japan). Nippon Kogyo Gijutsu Shikensho Hokoku, 17: 103-12(May 1968). (In Japanese).

Alkyl methacrylate monomers were grafted onto polypropylene fibers by γ irradiation in the vapor state. The rates of grafting at 25°C inversely corresponded to the order of the boiling points of monomers, and the autoacceleration was observed, which was similar to that of liquid-phase graft copolymerization. The amount of adsorption of monomers onto the backbone polymer depended on the vapour pressures of monomers. But the rates of grafting linearly increased at 80°C, and when the vapour pressure of monomers was kept constant the difference of rates was small among monomers. The occluded homopolymers occupied 35 to 45% of the apparently grafted amounts of methacrylates, and the effect of irradiation temperature on their molecular weights seemed to be negligible. The melting range of grafted fibers measured by differential calorimeter widened with the increase of the percentage of grafting, and the crystalline part decreased. The grafted polymer seemed to affect the crystallization. Thermal decomposition temperature was also lowered with the increase of the percentage of grafting. The results were compared with those of the liquid-phase graft copolymerization. (NSA of Japan)

6174 GAMMA-RAY INDUCED TELOMERIZATION REACTIONS BETWEEN ALLYLIC COMPOUNDS AND CARBON TETRACHLORIDE. MAINLY ON THE STRUCTURE AND THE REACTIVITY OF CARBOXYLIC ACID ESTERS OF ALLYLIC ALCOHOLS. Okubo, Masao (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 17: 71-85 (Mar.-Apr. 1968). (In Japanese).

Gamma-induced telomerization reactions of allyl alcohol esters of eighteen carboxylic acids with CCl_4 were carried out, and the effects of the structures of the carboxyl residues on the reactivities of these esters were investigated. The consumption velocities of allylic double bonds and the production ratios of telomers were compared with each other on the basis of the electronic character and the bulkiness of the carboxyl residues. An interaction between the α-hydrogen atoms of the carboxyl residues and the allylic π-electrons was considered to retard the reactions. When the α-hydrogen atoms of the allyl group of allyl acetate were successively substituted by the methyl group, the steric hindrance was found to cause a regular effect on the velocities as well as on the production ratios. The effect of the steric hindrance caused by the methyl substituent on the β-position of the allyl group was discussed in relation to the degradative chain transfer mechanism. From the results on the effects of the initial concentration and of the reaction temperature, an apparatus was devised to prepare the telomers of lower molecular weights using the azeotropic mixture of CCl_4 and allyl acetate. The 2:1-telomer of allyl alcohol was found to change easily into a derivative of tetrahydrofurfuryl alcohol, which was also found to be obtained from the 2:1-telomers of allyl carboxylates in good yields. (NSA of Japan)

6175 STUDY OF POSITRON LIFETIME MEASUREMENTS IN TEFLON UNDER GAMMA RADIATION. Khan, M. N. G. A.; Carswell, D. J.; Bell, J. (Univ. of New South Wales, Australia). J. Phys., D (London), 1: 1833-6(Dec. 1968).

Positron lifetimes (τ_3) in commercial poly(tetrafluoroethylene) (Teflon) were measured as a function of ^{60}Co gamma irradiation of the polymer in air and in vacuum. The rates of decrease with respect to dose in both τ_3 and I_3 (positron intensity) were observed to be faster when irradiated in air than in vacuum. Conversion of o-Ps occurs due to the free radicals formed under irradiation. The decrease in τ_3 is due to quenching of o-Ps by the free radicals formed. The faster decrease in I_3 (compared to that in τ_3) with dose is ascribed to a combined effect of free-radical quenching and decrease in the amount of o-Ps formation due to increased crystallinity and/or Ps compound formation. (auth) (UK)

6176 MOESSBAUER STUDIES ON THE γ RADIOLYSIS OF SOLID POTASSIUM TRIOXALATOFERRATE(III). Dharmawardena, K. G.; Bancroft, G. M. (University Chemical Labs., Cambridge, Eng.). J. Chem. Soc., A, No. 11, 2655-9(1968).

The radiolytic decomposition and thermal annealing at 75 and 130°C of hydrated and anhydrous potassium trioxalatoferrate(III) was followed using Moessbauer spectroscopy. Using the Moessbauer parameters to identify the oxidation state and co-ordination of the radiolytic products it is shown that both compounds decompose to an octahedral Fe(II) compound via a thermally unstable Fe(II) intermediate, which is four-co-ordinate in the hydrated but six-co-ordinate in the anhydrous form. On thermal annealing, some of the unstable Fe(II) intermediate reverts to the initial Fe(III) compound, while the remainder is converted to the octahedral Fe(II) compound. The rates of decomposition and thermal annealing vary markedly from the hydrate to the anhydrous compound. (auth) (UK)

6177 RADIOLYSIS OF WATER VAPOR WITH FISSION FRAGMENTS. Boyd, A. W.; Miller, O. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 46: 3773-8 (Dec. 15, 1968). (AECL-2744).

Water vapor, and mixtures of water vapor with radical and electron scavengers, were irradiated with fission fragments at temperatures from 170 to 365°C and densities from 1 to 50 mg/ml. The unimolecular hydrogen yield is the same as in γ irradiations. In $D_2O-C_6H_{12}$ mixtures the HD yield and HD/H_2 ratio are lower than in γ irradiations and N_2O and SF_6 have little effect. The HD yield reaches a limiting value ($G(HD) \sim 4$) with increasing linear energy transfer suggesting that a fraction of the D atoms formed are hot. (auth) (Canada)

6178 REACTIONS OF ATOMIC AND MOLECULAR ACCELERATED TRITIUM IONS WITH FROZEN BENZENE. Firsova, L. P.; Kuklin, Yu. S. Radiokhimiya, 10: 607-8(1968). (In Russian).

Chemical effects induced in frozen organic substances by accelerated atomic and molecular ions of various energies were studied and compared using tritium-ion-bombarded solid benzene frozen on a layer of silver coated on a glass target cooled by liquid nitrogen. The benzene was exposed for 5 hr to irradiation with 2.5- and 1.0-keV atomic and molecular fluxes, with T^+ and T_2^+ density equal to 1.5×10^{-8} a/cm^2. Relative radiochemical yields of labeled compounds (cyclohexane, cyclohexadiene, benzene, product x 2, 6, and 7, and toluene) during the T^+ and T_2^+ irradiation are tabulated. (R.V.J.)

6179 RADIATION HEATING APPARATUS FOR PHYSICAL-CHEMICAL INVESTIGATIONS. Deryagin, B. V.; Lopatina, G. G.; Snitsyn, B. V.; Fedoseev, D. V. Zh. Fiz. Khim., 42: 2360-2 (Sept. 1968). (In Russian).

A radiation heating apparatus providing controlled heating of practically any solid or liquid material up to temperatures of the order of 3000°K is described. The density of the radiation beam in the central part of the focal trace exceeds 2000 W/cm^2. The system of contactless temperature measurement and thermal control was used in the apparatus. Pyrometric methods for substances with unknown degrees of blackness were briefly clarified. (tr-auth)

6180 CHANGES IN THE DIELECTRIC PROPERTIES OF SILVER OXALATE AND NITRITE ON RADIOLYSIS AND THERMAL DECOMPOSITION. Zhuravlev, V. K.; Khairetdinov, E. F.; Eroshkin, V. I.; Boldyrev, V. V. Zh. Fiz. Khim., 42: 2243-7 (Sept. 1968). (In Russian).

The decrease in conductivity in the early stages of radiolysis and thermal decomposition of $Ag_2C_2O_4$ and $AgNO_2$ is related to the fact that decomposition is begun from defective surface ions, which create effects on interstitial polarizations and conductivities. In later stages the dielectric constant and conductivity increase again as a result of accumulation of metallic product; then they again decrease as a result of gas evolution. (tr-auth)

6181 STUDIES ON FREE RADICALS PRODUCED BY IRRADIATION. VII. PHOTOINDUCED AND THERMAL RADICAL CONVERSIONS IN γ-IRRADIATED COPOLYMERS OF TETRAFLUOROETHYLENE AND HEXAFLUOROPROPYLENE. Iwasaki, Machio; Toriyama, Kazumi (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 17: 13-20(Jan.-Feb. 1968). (In Japanese).

A perfluorinated tertiary-carbon radical $\cdots CF_2-C(CF_3)-CF_3\cdots$ formed in γ-irradiated copolymers of tetrafluoroethylene and hexafluoropropylene is converted into the radical $\cdots CF_2-CF(CF_2)-CF_2\cdots$ by illumination of uv light at 77°K and the process is reversed by the thermal annealing. The uv absorption spectra of this copolymer containing perfluorinated tertiary-carbon radicals were also measured and a strong absorption was found at 2,650 Å. The wavelength dependence of the radical conversion indicates that the photoisomerization of the tertiary-carbon radical is induced by the absorption of this light. In addition, it was found that γ irradiation at 77°K gives the radical $\cdots CF_2-CF(CF_2)-$

$CF_2\cdots$ as a forerunner radical of the tertiary-carbon radical found in room-temperature irradiation. (NSA of Japan)

6182 NATURE OF SHORT-LIVED PARTICLES FORMED DURING THE RADIOLYSIS OF FORMAMIDE. Fel', N. S.; Dolin, P. I.; Sharpatyi, V. A. (Inst. of Electrochemistry, Moscow. Inst. of Chemical Physics, Moscow). Khim. Vys. Energ., 2: 189-90(Mar.-Apr. 1968). (In Russian).

The nature of short-lived, ultraviolet-absorbing particles formed during the radiolysis of formamide was examined on the basis of the optical and EPR spectra of the irradiated frozen compound. The 85 vol % formamide–15 vol % H_2O mixture was exposed to the γ radiation of a ^{60}Co source. It was found that irradiated $LiClO_4$ in formamide exhibited a similar spectrum, possessing maxima at 300 and 550 nm. The uv spectra of frozen, liquid, and dissolved formamide were similar, indicating that they are due to the same particle. The 550-nm absorption in the solid may be attributed to electron capture, with a very low radiation yield. The EPR spectrum of the frozen formamide is attributed to the HCONH radical, in which the unpaired electron interacts with the nitrogen nucleus and two protons. This radical absorbs in the uv range. (TTT)

6183 HOMOLYTIC HYDROXYLATION OF NAPHTHALENE IN OXYGENATED AQUEOUS SOLUTIONS BY γ RADIOLYSIS AT HIGHER TEMPERATURES. Balakrishnan, I.; Reddy, M. P. (National Chemical Lab., Poona). J. Phys. Chem., 72: 4609-13(Dec. 1968).

G values for naphthol formation in the γ radiolysis of naphthalene dissolved in oxygenated water in sealed tubes rise from 0.28 to 1.44 over the temperature range 55 to 120°C and thereafter fall. The solubilities of naphthalene and of oxygen in water appear to be the two major controlling factors. The temperature dependence of the ratio of α- and β-naphthols in the product is discussed briefly in the light of what is known of the mechanism of homolytic substitution in aromatic hydrocarbons. (auth)

6184 RADIATION POLYMERIZATION IN BINARY SYSTEM MALEIMIDE MONOMER–FLUORENE. Ivanov, V. S.; Petrukhno, L. A.; Kozhevnikov, S. P. Vysokomol. Soedin., Ser. A, 10: 2399-2404(Oct. 1968). (In Russian).

Binary systems N-phenylmaleimide–fluorene and maleimide–fluorene are characterized with simple eutectics and absence of solid solutions. Increase of fluorene content up to eutectic composition brings increase of interphase area and number of defects. Rate of radiation solid state polymerization of N-phenylmaleimide is increased with fluorene content. For maleimide inhibition with fluorene is observed. The different effects are accounted for different role of structure of defects at polymerization of both monomers. Rates of imides polymerization when the monomers are present both in melt and in solid phase are determined mainly by rate of liquid phase polymerization. (auth)

6185 EFFECTS OF IONIZING RADIATIONS ON WOOL. PART II. CHEMICAL MODIFICATIONS OF KERATINS. Di Modica, G.; Marzona, M. (Univ., Turin). Text. Res. J., 38: 1208-9 (Dec. 1968).

Variations in content of some amino acids as a result of γ-irradiation of wool in nitrogen and oxygen are reported. N-terminal amino acids were determined by dinitrophenylation, the C-terminal amino acids by hydrazinolysis. Determinations of lanthionine, cysteic acid, and total amino acid content, were performed on hydrolyzed samples. Cystine and cysteine were determined polarographically. Amino acid loss increased with an increase in radiation dose, but, except for cystine, recovery was never lower than 90%. Qualitative tests indicated no breakdown of amide linkage or polypeptide chains, but pointed to a breakdown of S–S linkages in keratin. (J.G.B.)

6186 IRRADIATION VESSEL FOR HIGH TEMPERATURES AND PRESSURES. Marsh, W. R. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., E (London), 1: 1183-4 (Dec. 1968).

A simple pressure vessel is described, embodying a single valve and seal, which is suitable for the irradiation of organic substances at pressures up to 2000 lb $in.^{-2}$ and temperatures up to 400°C. (auth) (UK)

6187 PULSE-RADIOLYTIC INVESTIGATION OF SOME ELEMENTARY PROCESSES OF SILVER REDUCTION. Pukies, J.; Roebke, W.; Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Ber. Bunsenges. Phys. Chem., 72: 842-7 (Nov. 1968). (In German).

Several fast elementary processes in the reduction of Ag^+ in aqueous solution, which take place within micro- or milliseconds, were investigated. Anomalous valency states of silver are found by disproportionation of short-lived intermediates. The formation of nuclei of colloid silver that contain more than three silver atoms requires some milliseconds. The absolute rate constants and optical absorption spectra of the products of the following elementary reactions were determined: $e_{aq}^- + Ag^+ \rightarrow Ag$, $Ag + Ag^+ \rightarrow Ag_2^+$, $Ag_2^+ + Ag^+ \rightarrow Ag^{3+} + Ag_2$, $Ag_2 + Ag^+ \rightarrow Ag_3^+$, and $Ag^{2+} + Ag^{2+} \rightarrow Ag^{3+} + Ag^+$. The oxidation of the Ag^+ ion by the OH radicals was also studied. (auth)

6188 RADICAL DECAY KINETICS IN ORGANIC GLASSES. SPATIAL EFFECTS AND ISOTOPE EFFECTS. French, William G.; Willard, John E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-1715. J. Phys. Chem., 72: 4604-8(Dec. 1968).

Radical decay kinetics show that 3-methylpentyl radicals produced by γ irradiation of 3-methylpentane (3MP) glass at 77°K disappear by combination at random with other radicals in the matrix rather than by geminate recombination or intraspur or intratrack combination. By contrast, 3-methylpentyl radicals produced by hydrogen abstraction by hot hydrogen atoms formed by photolysis of HI in 3MP glass decay much faster and by a process which is first order in dose rather than second order. This indicates that the mechanism of decay is combination of each radical with the geminate iodine atom left by the hot hydrogen atom which produced the radical. It is shown that the rate of decay of methyl radicals produced from methyl halides in organic glasses at 77°K may be either first order in dose and exponential with time ("pure" first order) or first order in dose and not exponential with time ("composite" first order) depending on the matrix. The pure or composite first-order processes must occur by geminate recombination, with the rate-determining process being the thermal relaxation of geometrical constraints placed on the radicals by the matrix. Of great interest is the observation that the rates of radical decay in predeuterated 3MP and in predeuterated methylcyclohexane glasses at 77°K are very much slower than in the protiated matrices but approach the rates in the latter as the temperature is increased. (auth)

6189 ENDOR STUDY OF IRRADIATED L-GLUTAMIC ACID DEUTEROCHLORIDE. Whelan, D. J. (Roswell Park Memorial Inst., Buffalo). J. Chem. Phys., 49: 4734-9(Dec. 1, 1968).

X irradiation of L-glutamic acid·DCl yields the free radical $DO_2C-CH\cdot-CH_2-CH(ND_3^+)(CO_2D)$. The hyperfine splitting tensors were calculated from ENDOR data, and from the subsequent analysis of these data, the structure of this radical was defined. This result was verified from an analysis of the ESR (electron spin resonance) spectra of x-irradiated 2,3,3-trideutero-L-glutamic acid·HCl. (auth)

6190 EPR STUDY OF IRRADIATED ZINC ACETATE DIHYDRATE SINGLE CRYSTALS. Tolles, W. M.; Crawford, L. P.; Valenti, J. L. (Naval Postgraduate School, Monterey, Calif.). J. Chem. Phys., 49: 4745-9(Dec. 1, 1968).

X-ray irradiation of zinc acetate single crystals at 77°K with subsequent examination at 133°K reveals initially an intense EPR signal due to methyl radicals. Decay of the methyl radicals is accompanied by a corresponding increase in another species shown to be the $\cdot CH_2CO_2^-$ radical. The proposed mechanism is a simple abstraction of a hydrogen atom by the methyl radical from a neighboring acetate ion. In support of this mechanism, observation of the reaction using $Zn(CH_2DCO_2)_2\cdot 2H_2O$ indicates an isotope effect. The $\cdot CH_2CO_2^-$ radicals are produced in two magnetically distinct sites. Spectra taken over a range of temperatures reveal both the slow and rapid exchange of the hydrogen atoms. The barrier to internal rotation is 5.0 ± 1.0 kcal/mole, with less than two entropy units of activation. Parameters characterizing the $\cdot CH_2CO_2^-$ radical are determined with a 12-parameter least-squares calculation utilizing spectra taken at 55 different crystal orientations. The radical is planar with an HCH bond angle of 116.9°. The coupling constants are compared with other radicals using molecular-orbital calculations. (auth)

Radiochemistry

Refer also to abstract 6398.

6191 CHEMICAL BEHAVIOR OF ^{132}I FORMED BY DISINTEGRATION OF ^{132}Te IN ORGANIC MEDIUM. IV. PHENYL TELLURIDE (^{132}Te) IN SOLUTION IN TOLUENE AND CARBON DISULFIDE AND BUTYL TELLURIDE (^{132}Te) IN SOLUTION IN CARBON DISULFIDE. Llabador, Y.; Adloff, J. P. (Centre de Recherches Nucleaires, Strasbourg). Radiochim. Acta, 9: 171-2(Aug. 1968). (In French).

The role of the solvent at the moment of the reactions of ^{132}I with the radicals coming from the vestiges of the parent compound was studied in liquid and solid phase in the following three systems: $(C_6H_5)_2\ ^{132}Te$ in toluene and carbon disulfide and $(C_4H_9)_2\ ^{132}Te$ in carbon disulfide. Under the effect of conversion and Auger electrons, the solvent undergoes radiolysis in the vicinity of the decay

site. The decrease of the yield in parent iodide observed in all the solid systems is due to phenomena accompanying the crystallization which destroys the homogeneity of the mixture. At the interior of the solute crystals the yield of the parent iodide is equal to the yield obtained with liquid organotellurides without solvent. At low concentrations, there is a decrease in the yield of the parent iodide. In liquid phase the yield in parent iodide depends on the nature of the solvent. (J.S.R.)

6192 PREPARATION OF PHENYLXENONIUM DERIVATIVES IN β DECAY OF RADIOACTIVE IODINE ISOTOPES IN IODOBENZENE. Toropova, M. A.; Nefedov, V. D.; Levchenko, A. V.; Saikov, Yu. P. Radiokhimiya, 10: 611-13(1968). (In Russian).

The concentration of phenylxenon derivatives in iodobenzene, iodobenzene–chloroform solutions, and in iodobenzene coated on (80 to 100 mesh) crystals of $KClO_4$, $KB(C_6H_5)_4$, KBF_4, K_2SO_4, KNO_3, and KCl was observed. Tabulated data on the β-decay of radioactive isotopes in the iodobenzene composition showed that in the absence of stabilizing anion the phenylxenonium ions produced undergo a total disintegration. Formation of xenon compounds during phenylxenonium accumulation on ion crystals of $KClO_4$ and KBF, etc., indicates that in this case stabilization of $[C_6H_5Xe]^+$ ion by anion is possible. The yield of chemically bound xenon revealed that the anion stabilizing ability varied in the series: ClO_4^-, $B(C_6H_5)_4^-$, BF_4^-, SO_4^{2-}, NO_3^-, and Cl^-. (R.V.J.)

6193 PREPARATION OF PHENYLXENONIUM DERIVATIVES IN β DECAY OF RADIOACTIVE IODINE IN DIPHENYLIODONIUM SALTS. Toropova, M. A.; Nefedov, V. D.; Levchenko, A. V.; Matveev, O. G. Radiokhimiya, 10: 613-16(1968). (In Russian).

The concentration of decay products from beta decay of ^{131}I in diphenyliodonium salts at 0 to 1°C and in the absence of light took place in the following systems: $(C_6H_5)_2\ ICl_4$ crystals, perchloric acid, aqueous, and alkali solutions of $(C_6H_5)_2\ ICl_4$, $(C_6H_5)_2$ ICl crystals, aqueous and hydrochloric solutions of $(C_6H_5)_2$ ICl, and salt solutions of $(C_6H_5)_2\ IBF_4$, $(C_6H_5)_2\ IHSO_4$, and $(C_6H_5)_2\ INO_3$ in specific 0.1N acids. Tabulated data revealed that chemically bound xenon formed only in perchloric solutions of diphenyliodonium perchlorate. Radioactive iodine decay in $(C_6H_5)_2\ ICl_4$ aqueous or alkali solutions does not result in the formation of xenon compounds. Chemically bound xenon was not found in the $(C_6H_5)_2$ ICl crystals either. The diminishing yield of chemically bound xenon in the anion series of ClO_4^-, BF_4^-, HSO_4^-, NO_3^-, and Cl^- corresponds with the diminishing stabilizing ability of anions and stability of ionium ions containing these anions. (R.V.J.)

6194 ROLE OF POLYNUCLEAR SPECIES IN THE PROCESSES FOLLOWING NUCLEAR TRANSFORMATIONS IN SOLIDS. Maddock, A. G.; Collins, K. E. (State Univ. of New York, Buffalo). Can. J. Chem., 46: 3924-6(Dec. 15, 1968).

The hypothesis that recoil atoms from nuclear transformations have a high probability of forming polynuclear complexes in ionic solids is shown to correlate a wide variety of experimental observations. (auth) (Canada)

Separation Processes

6195 (AERE-R-5023) EXTRACTION OF URANIUM FROM SEA WATER. PART I. THE PHYSICAL AND CHEMICAL STATES OF URANIUM IN SEA WATER. Kennedy, J. (Atomic Energy Research Establishment, Harwell (England)). Sept. 1965. 10p. Dep. CFSTI. UK.

Uranium (3.34 μg/l) in natural seawater is in true solution as the anionic uranyl tricarbonate complex $UO_2(CO_3)_3^{4-}$. Less than 0.1% of the uranium present in sea water is adsorbed on particulate matter. (auth)

6196 (ARH-SA-4) RECOVERY OF Am, Cm, AND Pm FROM SHIPPINGPORT REACTOR FUEL REPROCESSING WASTES BY SUCCESSIVE TBP AND D2EHPA EXTRACTIONS. Boldt, A. L.; Ritter, G. L. (Atlantic Richfield Hanford Co., Richland, Wash.). [nd]. 53p. (CONF-680204-3). Dep. CFSTI.

From American Institute of Chemical Engineers Society Meeting, Corvallis, Ore.

The development and performance of the TBP batch extraction and D2EHPA solvent extraction processes for recovery of americium, curium, and promethium from the Shippingport reactor fuel reprocessing wastes are described. The Zircaloy fuel cladding was penetrated with a Zirflex dissolution and the UO_2 dissolved in a nitric acid leach. The dissolved Shippingport fuel was reprocessed with a modified Redox solvent extraction flow sheet. The waste solution was adjusted to a TBP batch extraction feed solution. The Am, Cm, and rare earths were back-extracted from the TBP phase with HNO_3. The dilute solutions were concentrated by evaporation and Am, Cm, and rare earths extracted into D2EHPA. A total of about 1100 grams of Am, 60 grams of Cm, and 200 grams of Pm was successfully recovered with net recovery efficiencies of about 85%. (M.C.G.)

6197 (GAMD-7657) REPROCESSING HTGR HEX BLOCK FUELS AT THE NUCLEAR FUEL SERVICES PLANT. Shefcik, J. J. (Gulf General Atomic, Inc., San Diego, Calif.). Jan. 23, 1967. Contract AT(04-3)-167. 63p. Dep. CFSTI.

Changes made in the HTGR fuel element design since the initial study on reprocessing HTGR fuels at the NFS plant was performed have necessitated some changes in the head-end auxiliary processes. However the basic burn-leach process with two burn-leach lines considered in the previous study remains the same. Subsequent development confirmed it as the most attractive head-end process for HTGR-type fuels. The inclusion of the silicon carbide coating on the fissile particles requires additional head-end process steps. During the fuel element burning operation, the silicon carbide coating is not removed. Therefore, a screening step is needed to separate the fissile particles from the burner ash. The separated fissile particles are placed in high-integrity containers that are sealed by welding. These containers are then placed in a fissile particle storage vault sized to hold the entire fissile particle container yield from the entire assumed fuel processing period of 7.5 yr. For cost estimating purposes, it is assumed that, starting at the end of the processing period, the containers will be shipped to a salt mine repository for ultimate disposal. It is further assumed that such a repository will exist at that time. Since the residual uranium in the fissile particles is predominately ^{236}U, reprocessing of the fissile particles for uranium recovery was not considered in this study. An economic assessment would be made to determine the value of the fissile particles before the fuel was shipped for ultimate disposal. The change in fuel element geometry has only minor effects on fuel handling. Larger diameter fuel storage containers and larger crushers and crusher auxiliaries are needed. Assumption of early full capacity operation of the reprocessing plant eliminates the requirement for a large solvent extraction feed accumulation tank similar to that specified in the earlier study. On the basis of the estimated reprocessing load, 540 process days are required at the NFS plant during the assumed 7.5-yr operating period. With the addition of 180 days for plant turnaround, the total number of NFS revenue days chargeable to HTGR fuels would be 720. Reprocessing costs for HTGR fuels are estimated to be $51,077 per revenue day. The cost per kilogram of actinides in the unirradiated HTGR fuel is $129. These costs include amortization charges for the HTGR head-end facility, which is estimated to cost $9,480,000. The estimated NFS reprocessing charges for HTGR hex block fuels as made by General Atomic are lower than those previously estimated for HTGR rod-type fuels. This decrease in reprocessing cost is due to the increase in the estimated quantity of HTGR fuel available for reprocessing and the resultant increase in the number of revenue days over which the capital cost of the HTGR head-end facility is amortized. (auth)

6198 (K-L-6223) THE OAK RIDGE GASEOUS DIFFUSION PLANT FUEL REPROCESSING PROGRAM. Merriman, J. R.; Pashley, J. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). [1968]. Contract W-7405-eng-26. 54p. (CONF-680613-2). Dep. CFSTI.

From Fluoride Volatility Meeting, Golden, Colo.

Conceptual plant designs are being developed for fluoride volatility fuel reprocessing. Nuclear safety aspects of dry volatility systems, cold trapping of UF_6 and PuF_6, sorption of UF_6 on solid sorbent materials, and fission product compositions in spent fuels are being studied. Experimental efforts included: semiworks processing of simulated fuel assemblies, recycle compressor development and testing, corrosion studies, components testing, and investigations of consequences of BrF_5 spills. (M.C.G.)

6199 DISTRIBUTION AND SEPARATION DIAGRAMS IN THE SYSTEM $LU(NO_3)_3$–HNO_3–H_2O–$(C_4H_9O)_3PO$ AT 25°C. Nikolaev, A. V.; Ryabinin, A. I. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 9, Ser. Khim. Nauk, No. 4, 41-51(July 1968). (In Russian).

The combined extraction of lutetium nitrate and nitric acid with undiluted tributyl phosphate was studied at 25°C by the ray method and by the analysis of the distribution, salting-out and separation diagrams. The compound $Lu(NO_3)_3 \cdot 6HNO_3$ is extracted into organic phase under certain conditions with a mean error in stoichiometry of ±0.5 HNO_3. (auth)

6200 REACTION OF PuO_2 WITH MOLTEN $MgCl_2$. Wenz, D. A.; Johnson, I. (Argonne National Lab., Ill.). Inorg. Nucl. Chem. Lett., 4: 735-8(Dec. 1968).

A study of this reaction was made in connection with molten salt pyrochemical reprocessing of nuclear reactor fuels. A step in such processes is reduction of UO_2 or PuO_2 to the metals by dispersing the oxide in a molten salt which is agitated with a

liquid alloy containing a reducing agent. It was found that whereas PuO_2 could be rapidly reduced with a liquid magnesium alloy and alkali chlorides mixed with 5 mole % MgF_2, UO_2 required salts containing ~50 mole % $MgCl_2$ plus some fluoride for rapid reduction. Since all reduction conditions, except salt composition, were the same, it appeared that a factor influencing oxide reducibility must be differences in the way the oxides interacted with the salts. The solubility of UO_2 in the molten salts employed was known to vary from ~0.01 to 0.03 wt.%, but data were not available for PuO_2 with molten salts containing $MgCl_2$. The system used for study was PuO_2 with 50 mole % $MgCl_2$; 30 mole % NaCl; and 20 mole % KCl, at 750°C. The quantity of Pu dissolved in the salt corresponded to the measured evolution of Cl_2; Pu was assayed by α-counting. The Pu concentration in the salt mixture increased slowly with time to >5 wt.% (using Ta crucibles), and saturation appeared not to have been reached even after 24 hr when sufficiently large amounts of PuO_2 were present. The salt solutions were blue in colour, characteristic of Pu(III), and indicating that an oxidation–reduction reaction was occurring. The reaction appeared to be represented by $PuO_2 + MgCl_2 = PuOCl + MgO + \frac{1}{2} Cl_2$. Studies were also made using alumina and fused silica crucibles, and with Pb and Zn mixed with the $PuO_2/MgCl_2$. Reaction was slow and incomplete in fused silica equipment, in contrast with the relatively rapid appearance of Pu in the salt when Ta was used. The extent of reaction was low with Pb present, but almost quantitative with Zn. (UK)

6201 STUDIES ON ION EXCHANGE RESINS FOR THE REMOVAL OF RADIONUCLIDES FROM MILK. Walker, J. P. (Southeastern Radiological Health Lab., Montgomery, Ala.); Edmondson, F. L. Health Phys., 16: 85-91(Jan. 1969).

Polystyrene and phenolformaldehyde sulfonic acid ion exchange resins having identical milliequivalent quantities of exchange capacity were compared for relative removal efficiencies of ^{85}Sr, ^{134}Cs and ^{133}Ba from in-vivo labeled raw whole milk. An inorganic exchanger was also compared for ^{85}Sr removal. The optimum cross-linkages and mesh sizes were determined for polystyrene sulfonic acid resins for ^{85}Sr removal. The inorganic silicate exchanger gave very poor ^{85}Sr removal and was therefore deleted from further study. The low cross-linkage (high porosity) polystyrene sulfonic acid resins gave the highest ^{85}Sr removal for the 16 to 50 mesh size. The 50 to 100, 100 to 200, and 200 to 400 mesh polystyrene sulfonic acid resins were found to be statistically equivalent for ^{85}Sr removal and superior to the 20 to 50 mesh. The optimum divinylbenzene cross-linkage for the first meshes was found to be 12%. The phenolformaldehyde resins gave the highest ^{134}Cs removal. There was very little difference in ^{133}Ba removal for all the resins tested. For 8 min milk-resin contact time the polystyrene sulfonic acid resins gave a maximum ^{85}Sr and ^{133}Ba removal of 84.5 and 88%, respectively. The phenolformaldehyde sulfonic acid resins gave a maximum ^{134}Cs removal of 85%. (auth) (UK)

6202 EXTRACTION OF THE SULFOCYANIDES OF URANYL AND THORIUM WITH FURFURYL ALDEHYDE. Spaccamela Marchetti, Elena (Istituto di Chimica Industriale del Politecnico, Turin). Ann. Chim. (Rome), 58: 801-9(July 1968). (In Italian).

The extraction of sulfocyanides of uranyl and thorium with furfurylic aldehyde was studied. The distribution coefficients with the variation in metal concentration and excess of alkaline sulfocyanide were determined. The formation of the complexes $UO_2(CNS)_2 \cdot$2-furaldehyde and $Th(CNS)_4 \cdot$2-furaldehyde was noted. It was also observed that KCNS greatly increases the reciprocal solubility between water and 2-furaldehyde; consequently, the ternary diagram at 20°C of water–potassium sulfocyanide–2-furaldehyde was determined. The critical point was found to correspond to the composition 60% water, 31% 2-furaldehyde, and 9% sulfocyanide. (BBB)

6203 DEPOSITION OF RADIORUTHENIUM ON METAL CHIPS FROM WASTE WATERS. Johannsen, K.-H. Isotopenpraxis, 4: 431-5(Nov. 1968). (In German).

Electroionic deposition on various metals from real and simulated waste waters containing ^{106}Ru was studied as a function of bond type and concentration of the ruthenium, salt concentration, pH, temperature and flow rate of the waste water. The efficiency of the metals increased in a sequence Cu < Al ≪ Zn < Fe, while deposition rate of the ^{106}Ru from its compounds decreased in the sequence Ru^{3+}-chloride > Ru^{4+}-nitrate > $RuNO^{3+}$-chloride > $RuNO^{3+}$-nitrate. Decontamination factors of 40 were obtained for flow rates of less than 5 bed volumes per hour in the favored pH range of 3.5 to 4.5 even for real waste waters by using iron. A high content of salts of the waste waters had favorable influence on the deposition. (auth)

6204 REPROCESSING OF FUEL ELEMENTS OF FAST BREEDER REACTORS. Ochsenfeld, W. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech., 13: 422-5(Aug.-Sept. 1968). (In German).

Studies made at the Karlsruhe Nuclear Research Center on the possibilities of reprocessing spent fuel elements of fast breeder reactors have led to the selection of an extraction procedure using TBP. The procedure adopted differs from the Purex process normally used by the high concentrations of Pu and fission products and the exposure of the extraction agent to intense radiations. The risk of an insufficient radiation resistance of the extraction agent to be feared in the case of the reprocessing of highly spent fuel elements has been reduced by reprocessing simultaneously the fissile core and the fertile layer. The burnup of this mixture is comparable to that of the fuel elements of thermal reactors. The possibility of reprocessing the fuels of fast breeders and other nuclear fuels in a common high-capacity installation and of obtaining thus a high return argues in favor of the Purex process adopted. The studies made up to the present have revealed no insurmountable difficulties. Fuel samples having a burnup up to 100,000 MWd/t are being tested in a laboratory-scale installation. (tr-auth)

6205 CONCERNING THE ARTICLE BY V. M. VDOVENKO ET AL ON THE METHOD OF SEPARATION OF RADIOACTIVE TRACER ^{95}Zr FROM ^{95}Nb. Tsaletka, R. Radiokhimiya, 10: 620(1968). (In Russian).

In reference to the continuous method for purification of ^{95}Zr from its daughter activity of ^{95}Nb suggested by V. M. Vdovenko, et al. (Radiochimiya, 1: No. 3, 364(1959)) it was found that depending on the type of the glass wool the absorption of ^{95}Nb did not exceed 60 to 85% (during 2 to 10 days). Thus, the use of glass wool did not prove to be sufficient. Some silicate absorbents at identical conditions are capable of absorbing 97 to 99.5%. (R.V.J.)

6206 PLATINUM FOR HIGH TEMPERATURE CRUCIBLES USED IN PROCESSING RADIOACTIVE WASTES. Tuthill, E. J.; Strickland, Gerald; Weth, G. G. (Brookhaven National Lab., Upton, N. Y.). Ind. Eng. Chem., Process Design Develop., 8: 36-43(Jan. 1969).

In development of the Brookhaven phosphate glass process for converting highly radioactive aqueous wastes to stable solids, platinum proved a satisfactory material of construction for the high-temperature crucible. In pilot plant operation with simulated atomic reactor wastes, no apparent deterioration of a platinum crucible was observed after 16,000 hours at temperatures between 900 and 1200°C. In the presence of molten phosphate, chemical reducing conditions must be avoided to prevent rapid deterioration of platinum vessels because of formation of lower melting alloys. Tests to evaluate the useful life of platinum included both long-term creep strength measurements at 1250°C and waste component penetration studies. (auth)

6207 ENGINEERING-SCALE STUDIES OF THE FLUORINATION OF URANIUM OXIDE WITH BROMINE PENTAFLUORIDE. Holmes, John T.; Koppel, Lowell B.; Gabor, John D.; Ramaswami, D.; Jonke, Albert A. (Argonne National Lab., Ill.). Ind. Eng. Chem., Process Design Develop., 8: 43-51(Jan. 1969).

The fluorination of U_3O_8 to volatile UF_6 with gaseous BrF_5 diluted with nitrogen, after oxidation of UO_2 nuclear fuel pellets to U_3O_8 fines, was studied using an engineering-scale fluidized-bed reactor system. The fluidized bed of inert alumina serves as a heat transfer medium for the exothermic chemical reactions. UO_2 pellets were oxidized at 450°C, using 19.2 volume % oxygen in nitrogen. For the fluorination step a fractional factorial experiment consisting of eight runs was conducted to determine, in a minimum number of runs, the effects of process operating conditions on the UF_6 production rates, BrF_5 utilization efficiencies, and diminishing sphere rate constant. Results of the experiment showed that in the fluorination of U_3O_8 fines to UF_6 using BrF_5, a higher temperature, a higher inlet partial pressure of BrF_5, a greater fluidizing gas velocity, and a larger amount of UO_2 charged to the reactor increased UF_6 production. A higher temperature and a larger amount of UO_2 charged to the reactor increased the BrF_5 utilization efficiency. Favorable conditions (within the ranges studied) for the BrF_5 fluorination are: a temperature of 300°C, an inlet partial pressure of BrF_5 of 0.29 atm, a fluidizing gas velocity of 0.89 foot per second, and a UO_2 charge of 4.4 kG. These results should not be significantly affected by use of 48- to 100-mesh or—100-mesh alumina or the presence of fission product compounds. Although no runs were made at this combination of conditions, the expected average UF_6 production rate and average BrF_5 utilization efficiency for fluorinating the first 75% of the uranium are 164 lb UF_6/(hr) (ft^2) and 60%, respectively. These results are considered highly acceptable for process application. (auth)

6208 PROCESS FOR EXPLOITATION OF URANIUM AS URANYL SULFATE FROM BITUMINOUS SLATE. Svenke,

J. E. K. (to Aktiebolaget Atomenergi). Swedish Patent 211,526. Mar. 14, 1967. Filed Feb. 20, 1958. (In Swedish).

A process is described for separation of uranium from materials containing organic substances and sulfur, e.g., bituminous slate. The material is precalcinated above 1000°C, where SO_3 is completely dissociated. The fumes are cooled for heat recovery and led to an absorber for removal of SO_2. The absorbed SO_2 is released and mixed with air. The gas mixture is brought in contact with the pre-calcinated material below 800°C. The uranyl sulfate formed is exploited by leaching. The remaining gas mixture and the leach residue are added to the slate that is to be pre-calcinated. (Sweden)

6209 SEPARATION OF CARRIER-FREE SILVER FROM RHODIUM. Louw, W. J. (National Physical Research Lab., Pretoria); Robb, W. Inorg. Nucl. Chem. Lett., 4: 631-7(Nov. 1968).

Silver-105 is produced when Rh metal is irradiated with a cyclotron-produced beam of α-particles, according to the reaction $^{103}Rh(\alpha,2n)^{105}Ag$. An ion exchange separation method for the Ag is described, which depends on the extremely slow "anation" reactions by chloride ions of the hexaaquorhodium(III) complex ("anation" is replacement of a co-ordinated water molecule by a nucleophile). Elution profiles are shown for the separation of Rh and Ag. (UK)

6210 EXTRACTION OF GADOLINIUM, DYSPROSIUM, AND HOLMIUM BY TRIALKYL-PHOSPHINE OXIDE. COMMUNICATION 2. Popkov, I. N.; Tselik, I. N.; Pentkovskaya, T. A.; Sokolova, I. D. (Odessa Inst. of General and Inorganic Chemistry). Ukr. Khim. Zh., 34: 1066-8(1968). (In Russian).

Regularities of Ga, Dy, and Ho distribution between aqueous and organic phases during their extraction by trialkylphosphine oxide (TAPO) are described, as a function of equilibrium rare earth concentration in aqueous solution, by the Freundlich equation in a wide range from 0.005 to 1.0 g ion/l of rare earth. In order to confirm the accuracy of the Freundlich equation studies were made of regularities in Ga, Dy, and Ho extraction from nitric acid by phosphine oxide which in the organic phase formed a solvate of the $Ln(NO_3)_3$ TAPO type. (R.V.J.)

6211 SEPARATION OF ^{97}Zr AND ^{97}Nb RADIOACTIVE ISOTOPES. Pankratova, L. N.; Rudenko, N. P.; Gudym, L. S. Vestn. Mosk. Univ., Ser. II. Khim., No. 5, 41-3(Sept.-Oct. 1968). (In Russian).

A method was suggested for separation of ^{97}Nb and ^{97}Zr (zirconium concentration ranged from 0.015 to 1.85 mg/ml) by washing the column filled with glass wool. Zirconium was removed by washing the column with 10 M nitric acid. Niobium was then eluted by oxalic acid. (auth)

6212 ZIRCONIUM SORPTION FROM AQUEOUS-ORGANIC SOLUTIONS OF SULPHURIC ACID BY ION EXCHANGERS KY-2 AND AB-17. Belyavskaya, T. A.; Dobrushina, G. D. Vestn. Mosk. Univ., Ser. II. Khim., No. 5, 81-4(Sept.-Oct. 1968). (In Russian).

The addition of organic solvent to sulfuric acid solutions of zirconium was found to result in change of sorption both by cation exchanger and by anion exchanger. (auth)

6213 KINETICS OF ZIRCONIUM EXTRACTION BY β-DIKETONES. Ozerova, G. P.; Mel'chakova, N. V.; Peshkova, V. M. Vestn. Mosk. Univ., Ser. II, Khim., No. 5, 12-4(Sept.-Oct. 1968). (In Russian).

The influence of some factors (concentration of reagent, nature of β-diketone, and solvent) on kinetics of zirconium extraction by benzoylacetone, benzoyltrifluoroacetone, and thenoyltrifluoroacetone was investigated. (auth)

6214 MIXED SALT SOLUTION USED TO STRIP ^{131}I FROM ANION RESIN FOR REMOVING RADIONUCLIDES FROM MILK. Brooks, I. B.; Walker, J. P.; Rehnberg, B. F. (Southeastern Radiological Health Lab., Montgomery, Ala.). J. Dairy Sci., 51: 1923-5(Dec. 1968).

Waste cationic regenerating solution from a milk decontamination process was utilized to strip ^{131}I from the anion resin. It is necessary to remove the phosphate from the anion resin bed with five bed volumes of N NaCl to prevent the Ca and Mg in the regenerating solution from forming a phosphate precipitate. The ^{131}I is then stripped from the anion resin with 45 bed volumes of waste regenerating solution at 71°C, resulting in 96 to 98% ^{131}I removal. (auth)

6215 EVAPORATION–CONCENTRATION OF SYNTHETIC HIGHLY RADIOACTIVE WASTE SOLUTION BY SUBMERGED COMBUSTION. Iwamoto, Kazumi (Japan Atomic Energy Research Inst., Tokyo). Radioisotopes (Tokyo), 17: 517-22(Nov. 1968). (In Japanese).

A mixture of propane and O_2 in a quartz-made burner was used for submerged combustion of evaporated and concentrated synthetic Purex 1 WW waste solution. The boiling point of still residue was 10 to 16°C lower than that in the ordinary evaporator, and volume reduction of the waste solution was continued until the volume reduction ratio (volume of still residue/volume of feed) reached 0.3. The submerged combustion evaporator having a small, simple structure operated successfully, and thermal efficiency was high. The volume of off-gas may be reduced if CO_2 in the flue gas is removed and the combustion in the burner proceeds completely. The solution containing $Al(NO_3)_3$ was evaporated, and converted into solid after cooling the concentrate down to room temperature. (NSA of Japan)

6216 A REVERSED-PHASE THIN LAYER CHROMATOGRAPHIC SEPARATION OF THE LIGHT RARE EARTHS WITH A SPECTROPHOTOMETRIC DETERMINATION. Whitaker, Leslie, Arthur. Stockton, Calif., Univ. of the Pacific, 1967. 120p.

Thesis.

Two, three, four, five, and six rare earths were separated via reversed-phase thin layer chromatography, and selected sample spots were removed from the plate and determined by emission spectroscopy. Di-(2-ethylhexyl)phosphoric acid was used as the stationary phase. A small amount of hydrolytic decomposition of HDEHP resulted in a double front beyond which no ions were able to move. This created distinct problems such as the obtaining of lower than expected R_f values for certain rare earths and the loss of ions with higher R_f values when they became involved with the double front. Silica Gel HR, Silica Gel N, and MN-Cellulose 300 were selected and used as the adsorbents to retain the HDEHP for the separations. The most effective separations were found to take place on the cellulose. There was little difference noted between aqueous HCl and HNO_3 as mobile phases. At times it appeared that better resolution of the lanthanides was obtained with HNO_3, therefore, solutions of 0.5M to 0.75M HNO_3 equilibrated with HDEHP were employed for most of the separations. When the mobile phase passed over the adsorbent, an interfering band of impurities, caused by Fe and about 8 other impurities from the silica gel, was formed about 1.5 to 2 cm behind the solvent front. Purification of the silica gel partially solved this problem. A solution of 8-hydroxyquinoline-kojic acid in 60% ethanol was used to locate the positions of the R.E.-HDEHP spots on the developed plate. With the exception of La, which fluoresces brightly under ultraviolet light, all of the lighter rare earths (Ce to Tb) have a deep blue coloration under the ultraviolet light following the spraying of the plate with the detection reagent and the exposure of the plate to an atmosphere of NH_3 vapor. A semiquantitative analysis was obtained by the removal of selected spots from the thin layer plate and their subsequent analysis via emission spectroscopy. The stability of the R.E.-HDEHP coordination compounds increases with increased atomic number, Z. Therefore, at any aqueous acid concentration, the R_f values increase with decreasing atomic number. As the concentration of the stationary phase on the adsorbent is increased, the R_f values of the rare earths decrease. (Disser. Abstr.)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 6071 and 6079.

6217 (HASL-190) EXTERNAL RADIATION LEVELS ON BIKINI ATOLL, MAY 1967. Beck, Harold L.; Bennett, Burton G.; McCraw, Tommy F. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Dec. 1967. 79p. Dep. CFSTI.

An intensive radiological survey of the islands of Bikini Atoll was conducted in April to May 1967 for the purpose of determining the levels and components of the external gamma radiation fields in this former weapons testing area. Fourteen islands and the two island complexes of the atoll were surveyed with instrumentation which included a field gamma spectrometer system, a high pressure ionization chamber, scintillation and G. M. survey meters, and thermoluminescent dosimeters. A large number of soil samples were taken for laboratory NaI(Tl) and Ge(Li) gamma spectral analysis. Total exposure rates were found to vary considerably from site to site and island to island. Levels measured over soil ranged from less than 10 μR/hr to over 500 μR/hr. Major contributors to the radiation fields usually included ^{137}Cs, ^{60}Co, ^{125}Sb, and ^{102m}Rh with a large number of other isotopes present. The large amount and consistency of the data indicate that a reliable and comprehensive picture has been obtained of the external gamma radiation environment of the atoll. (auth)

6218 URANIUM ACTION IN A RESERVOIR. Gus'kova, V. N.; Gurfein, L. N.; Tikhonova, A. I. (Leningrad Research Inst. of Radiation Hygiene). Gidrobiol. Zh., Akad. Nauk Ukr. SSR, 2: No. 6, 53-7(1966). (In Russian).

The effects of uranium in the form of uranyl nitrate in a reservoir was studied. Uranium concentration of 1.0 mg/l of water inhibited the growth of microflora and hindered the self-purification process. The viability of daphnia and some algae decreased as U content increased. The concentration of 100 mg/l was bactericidal. The same level of activity when produced by ^{239}Pu in water did not affect the growth and development of microorganisms, bacteria, and algae. It was thus concluded that the toxicity of the uranium resulted from its chemical action. (D.H.M.)

6219 IN SITU MEASUREMENT OF MARINE SEDIMENT DENSITY BY GAMMA RADIATION. Preiss, K. (Negev Inst. for Arid Zone Research, Beer-Sheva, Israel). Deep-Sea Res. Oceanogr. Abstr., 15: 637-41(Oct. 1968).

Gamma-ray transmission equipment was designed to measure, non-destructively, the bulk density of sediment cores in the laboratory. However, because the water-sediment interface may be disturbed in even the best of cores, it was considered necessary to obtain in situ measurements. The equipment used to make such in-place density measurements is described, together with the results of observations made during July 1967 from the U.S.C.G.S. Davidson, in the Wilkinson Basin, 100 km east of Boston. The sediment in the Basin is a silty clay at a water depth of 280 m. Density may be measured either by gamma-ray scattering or transmission. With the former method the thickness of sediment layer "seen" by the probe is greater than 50 cm. With the transmission technique the vertical thickness of the layer of sediment "seen" is equal to the thickness of the scintillation (detection) crystal, which is usually between 2 and 5 cm. Since measurement of vertical variation of density was an important requirement, the transmission method was selected. (auth)

6220 ^{137}Cs AND OTHER GAMMA RADIOACTIVITY IN THE FLORIDA ENVIRONMENT: A STUDY OF SELECTED MEDIA. Roessler, Charles Ervin. Gainesville, Fla., Univ. of Florida, 1967. 181p.

Thesis.

Kinds, levels, and distribution of gamma-emitting radionuclides in the Florida environment were investigated because of the unusual levels and characteristic geographical patterns of cesium-137 found in Florida milk and forage in earlier studies. Beef and vegetables were selected as the most important media for sampling in May and June, 1966, and during January through July, 1967. Analyses were performed by gamma spectroscopy on triturated whole samples and gamma spectra were interpreted in terms of the individual contributing components by use of the simultaneous equations method. The most significant gamma-emitting radionuclide present was ^{137}Cs, and the evaluation of the data was concentrated on this nuclide. Levels of ^{137}Cs in both beef and vegetables showed geographical patterns of variation similar to those reported earlier by others in Florida milk. Maximum levels were found in the central and southern parts of the State, with intermediate levels in the northeastern and north central parts of the State, and the lowest levels in the northwestern part of the State. In addition, vegetable samples showed a marked difference from southeast to southwest, with average levels in the southeastern part of the State as low as in the northwestern part. Levels of ^{137}Cs in lower-quality meat from animals that had fed primarily on grass were much higher than those in high-quality meat from feed-lot animals. These levels were higher than any other levels reported in beef in the conterminous United States. There was no apparent difference in ^{137}Cs concentrations between leafy, fruit, and root categories of vegetables; although certain crops in each category did exhibit consistently higher levels than the other crops in the same category. Cesium-137 concentrations found in this study were compared to literature values, both to those reported for years previous to this study and to 1966 to 1967 values obtained by extrapolating published values to that time. The significance of the observed ^{137}Cs levels was evaluated in terms of the human intake of this nuclide. It was estimated that radioactivity intakes from locally produced food in Northwestern Florida would be similar to the national average. It was concluded that unusual environmental factors or mechanisms are involved in the levels of ^{137}Cs found in the Florida environment. The possibility of such mechanisms has important implications to waste disposal, hazard evaluation, and nuclear facility operation. The mechanisms were not identified but there is increasing evidence that the role of uptake from the soil is greater than than reported for most areas of the country. (Diss. Abstr.)

6221 SOIL DENSITY MEASUREMENTS WITH GAMMA-RAYS. Pirie, E.; Lin, K.; Taylor, D. (Univ. of Strathclyde, Eng.). Soil Sci., 106: 411-14(Dec. 1968).

Some experimental tests made with a gamma-radiation backscatter gage are presented. It is shown that by restricting the scattering angle to less than 90°, instead of allowing scattering angle s_h up to 180° as in the conventional instrument, the "soil-type" effect is substantially reduced. It is also shown that the counting rate maxima are obtained at some specific density = 16/d, where d is the source-detector distance, and that this formula may be employed to choose the geometry appropriate to covering any specific range of densities. (auth)

6222 STRONTIUM RETENTION IN ACID SOILS OF THE NORTH CAROLINA COASTAL PLAIN. Taylor, Alan W. (Dept. of Agriculture, Beltsville, Md.). Soil Sci., 106: 440-7(Dec. 1968).

The mechanism by which some acid soils of the Southeastern U. S. retain Sr was investigated. The Sr present in the soil samples was labeled with a solution of ^{85}Sr and extracted by centrifuge. The results showed that, when trace quantities of radiostrontium are equilibrated with some acid soils from the Coastal Plain of North Carolina for periods of 40 days, significant amounts—sometimes 40 percent cannot be recovered in rapid extraction with normal solutions of strontium nitrate. Isotopic equilibrium is approached only when the extraction is extended over a time equal to that taken for the original labeling. The mechanism of occlusion of this strontium is not a permanent fixation, but is due to a slow exchange reaction in which the rate-limiting step is a diffusion process acting within the exchanger matrix of the soil. The reaction does not appear to be characteristic of strontium alone, and is probably also shown by calcium ions. The rate of release of strontium is sensitive to the concentration and composition of the extracting solution, and all the occluded strontium is immediately released on destruction of the soil organic matter. The amounts of strontium occluded cannot be correlated with acidity, exchange capacity or clay mineral content, and are believed to reflect variations in the physical or chemical character of the organic matter in the soils examined. Since isotopic equilibrium is approached only over a period of 6 to 8 weeks, it is clear that rapid extraction methods are not likely to give satisfactory estimates of the amounts of radiostrontium that will be taken up by a crop that is grown to maturity on such soils. (auth)

6223 STUDIES IN I–Xe AND Pu–Xe DATING OF PILE-IRRADIATED ACHONDRITES. Hohenberg, Charles Morris Jr. Berkeley, Calif., Univ. of California, 1968. 53p.

Thesis.

Neutron irradiated achondrites were analyzed by mass spectrometry of the rare gases, released in stepwise heating experiments. In some cases the extracted xenon contains excess ^{129}Xe from the decay of now extinct ^{129}I. Results show that the Shallo-

water achondrite began to retain xenon simultaneously (within 1 or 2 million years) with ten chondrites previously studied. Assuming a continuous nucleosynthesis model, the onset of xenon retention in these bodies appears to have occurred 60 million years after the isolation of solar system material from galactic nucleosynthesis. The Lafayette achondrite, a meteorite which contains a small excess of ^{129}Xe, appears to have lost a substantial part of that isotope attributable to ^{129}I decay. Therefore any I-Xe formation interval found for this meteorite is probably in error. Excesses of the heavy isotopes of xenon in Pasamonte have been attributed to the decay of now extinct ^{244}Pu. A possible plutonium–uranium correlation is observed in this meteorite, which yields a Pu–Xe formation interval of 223^{+36}_{-46} million years. This result is questionable because of an observed rare gas loss during the irradiation and relatively large statistical errors in the data. Trace element abundances in these samples are determined from the production of rare gases by neutron capture reactions. Disagreements with previous measurements indicate a probable loss of rare gases from some of these samples during the neutron irradiation. (Diss. Abstr.)

Meteorology

6224 METHOD FOR DETERMINING γ FIELD VARIATIONS AT THE ATMOSPHERE LAYER. Karasev, V. F.; Lobanov, Yu. N.; Mytil, V. K.; Urazakov, E. I. (Inst. of Nuclear Physics, Moscow). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 9, 145-7(1968). (In Russian).

The results of radiometric measurements of an area from an airplane, showed that the γ-field parameters at certain standard elevations are functions of energy spectra of γ emission at flight elevation H and can be determined using height coefficients K_H resolved by the equation $K_H = (P_0/P_H)$, (where P_0 and P_H are doses at standard height and height of the flight H, respectively). A method was suggested for determining the variations of the height coefficients (or any other parameter describing γ-field variation). (R.V.J.)

6225 STUDIES ON FALLOUT PARTICLES. [PART] IX. Mamuro, Tetsuo; Matsunami, Tadao; Fujita, Akira; Yoshikawa, Kazuko (Radiation Center of Osaka Prefecture, Japan). Nippon Genshiryoku Gakkaishi, 10: 618-25(Nov. 1968). (In Japanese).

The fifth Chinese nuclear explosion on Dec. 28, 1966 is believed to have been a land surface burst of about 200 kt yield. The radionuclide fractionation appearing in individual hot particles (highly radioactive fallout particles) from this explosion has been investigated by γ-ray spectrometry. The activities of the 10 radionuclides ^{95}Zr, ^{97}Zr, ^{99}Mo, ^{103}Ru, ^{131}I, ^{132}Te, ^{133}Xe, ^{140}Ba, ^{141}Ce and ^{239}Np were determined, and the initial atom numbers of these nuclides contained in each sample were estimated. The fractionation factor defined with respect to ^{95}Zr was calculated in order to express the degree of fractionation. The results obtained are discussed in relation to the fission-product decay chains, and compared with that obtained on the hot particles from the earlier air bursts. A significant difference in radiochemical nature is revealed between the present hot particles from a surface burst and those from the previous air bursts. (auth)

6226 TOWARDS THE PRODUCTION OF A REPRODUCIBLE AEROSOL BY RADIOLYTIC METHODS. McGreevy, Gerard (St. Patrick's Coll., Maynooth, Ireland). Pure Appl. Geophys., 71: 190-7(1968/III).

A convenient constant reproducible aerosol has been a long-felt need for satisfactory research and development purposes in the field of Aitken nucleus studies. An account is given of a recent attempt to produce such an aerosol by radiolytic methods. It consists of the introduction of α-particle sources of different activities into nucleus-free air in aerosol containers. Condensation nuclei in the Aitken size-range are produced by radiolytic reactions in the air. The concentration, size, and size-distribution of the particles were measured for sources of various activities and the results are sufficiently consistent to allow one to state that radiolytic production seems a promising approach to the problem of providing aerosols of particles lying in the lower Aitken nucleus size range. (auth)

6227 CONTAMINATION OF JET PLANES BY NUCLEAR EXPLOSIONS. Allkofer, O. C. (Institut fuer Reine und Angewandte Kernphysik, Kiel). Atompraxis, 14: 473-6(Nov.-Dec. 1968). (In German).

In present jet transport flights, planes come into contact with radioactive fallout from nuclear explosions which has accumulated in the stratosphere, and are also exposed to an increased amount of cosmic radiation. The concentrations of radioactivity during recent years have been measured; likewise, contamination of planes has been measured for several years. The radiation protection of flight- and ground-personnel is discussed. (auth)

Mineralogy and Exploration

6228 (NP-17706) URANIUM FROM SWEDISH SLATE. Analysis Done by Aktiebolaget Atomenergi on Behalf of the Ministry of Finance About Large Scale Exploitation of Uranium from Slate in the Billingen Area. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Sept. 1968. 55p. (In Swedish). Dep.

An analysis was made on different alternatives for increasing the capacity of the Ranstad uranium mill. Investment, operational and capital costs are reported for capacities of 134, 550, 600, 1040, 1100, 1200, 1560, 1650, and 1800 tons U/yr. National supply is compared with external supply. It is concluded that import of uranium is secured for the main part of the 1970s. A recommendation is made that a decision on a possible increase in the capacity of the Ranstad mill be made in 1974. (Sweden)

6229 DISTRIBUTION OF THORIUM ISOTOPES IN FRACTIONATION OF A URANIUM ORE DRESSING. Born, H.-J.; Meyer, H. G. (Technische Hochschule, Munich). Z. Naturforsch., 23b: 1379-80(Oct. 1968). (In German).

The ratio of ^{230}Th to ^{232}Th, which is always present in uranium ores although not genetically of the U–Ra series, was determined in dressing fractions. Ore samples from Ellweiler, Grube Ratones (Spain) and Menzenschwand were investigated. Some analytical results are tabulated and show that the $^{232}Th/^{230}Th$ ratio is not constant. In the Ellweiler and Spanish samples, with decreasing H_2SO_4 concentration of the leach a significant enrichment of ^{230}Th up to fourfold was observed. The ore from Menzenschwand has a completely different behavior. (J.S.R.)

6230 GEOLOGY AND TECTONICS OF THE IDAHO PORPHYRY BELT FROM THE BOISE BASIN TO THE CASTO QUADRANGLE. Olson, Harry J. Tucson, Ariz., Univ. of Arizona, 1968. 214p.

Thesis.

The portion of the Idaho porphyry belt studied forms a northeast-trending polygon encompassing approximately 750 square miles in west-central Idaho. Geology was mapped along a series of irregular lines cross-cutting the north-east trend of the porphyry belt. The area is underlain by quartz monzonite of the Idaho batholith which, structurally and tectonically, occupies a unique position at the junction of arcuate segments of the Nevadan and Laramide orogenic belts and a belt of Tertiary plutonism. Metamorphosed xenoliths and roof pendants of sedimentary rock are common throughout the northern portion of the map area, but do not constitute a large volume of rock. Small Eocene and plutons of diorite, quartz monzonite, granodiorite, and pink granite intrude earlier rocks, but do not form a conspicuous element of the Tertiary intrusive features. The deforming stresses that provided the openings for the intrusion of the Tertiary plutons and dikes were not everywhere equally and uniformly applied in either intensity or direction, and the Idaho porphyry belt area is a composite of several well-defined dike swarms, differing in composition and age from the others, and controlled by its own set of guiding fractures. The forces controlling the emplacement of magma were vertical and caused doming and fracturing of the batholithic rocks in and around three intrusive centers. North-northeast and east-northeast trending fractures controlled the direction of the majority of the dikes. Older structures were also effective in controlling pluton and dike directions. After emplacement of the dikes the area was modified by Basin and Range type block faulting, the formation of intermontane basins, strike-slip faulting, Pleistocene glaciation, and periodic uplift and erosion. The area has been prospected from the early 1860s, and has produced small quantities of gold, silver, lead, zinc, and copper from placer and lode deposits. Minor tungsten and molybdenum mineralization is present but is uneconomic. The radioactive rare-earth placer deposits in Bear Valley were mined in the late 1950s and now represent an important low-grade reserve for uranium, thorium, columbium, tantalum, and the rare-earths, as well as magnetite, ilmenite, garnet, and monazite. (Diss. Abstr.)

6231 HEAT FLOW AND SURFACE RADIOACTIVITY IN THE QUIRKE LAKE SYNCLINE NEAR ELLIOT LAKE, ONTARIO, CANADA. Sass, J. H.; Killeen, P. G.; Mustonen, E. D. (Univ. of Western Ontario, London, Ont.). Can. J. Earth Sci., 5: 1417-28(Dec. 1968).

Heat flow was measured in seven diamond-drilled holes, ranging in depth from 300 to 900 m, in the Quirke Lake Syncline (82° 30'W, 46° 30'N, mean elevation 370 m). Values for individual holes vary from 1.20 to 1.40 with a mean of 1.32 ± 0.02 $\mu cal/cm^2s$, and no systematic variation was detected within the 50 km^2 area studied. Radiometric measurements with a portable, three-channel, gamma-ray spectrometer show a downward concentration (stratigraphically) of Th, U, and K within the lower part of the syncline,

with mean concentrations of 12.7 ppM, 3.3 ppM, and 1.9%, respectively. These data yield an average rate of heat production of 4.5 heat generation units (1 hgu = 10^{-13} cal/cm^{3}s). Taking account of the ore zones, the mean heat production from the syncline is about 6 hgu. Corrections for structural effects and heat production from the ore result in a value of 1.2 for the regional heat flow. This is within the range of other shield values, although somewhat higher than the average for the Canadian Shield. The high value is readily explained if the observed mean surface radioactivity persists to a depth of 7 to 10 km. (auth)

6232 SOME LOCALIZATION PECULIARITIES OF THE URANIUM-BEARING BITUMENS IN RED BEDS. Lepkii, S. D. (Inst. of Geology, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B, No. 10, 885-7(1968). (In Ukrainian).

A description is given of the uranium-bearing bitumens in epigenetically altered rocks of the Permian and Triassic systems. A close connection is emphasized between the processes of uranium ore formation and marginal parts of the oil-bearing area. It is established that localization forms of uranium-bearing bitumens appear to correlate with the properties of host rocks. An attempt is made to classify the deposit in question. (auth)

6233 URANIUM DEPOSITS IN THE JACKPILE SANDSTONE, NEW MEXICO. Nash, J. Thomas (Columbia Univ., New York). Econ. Geol., 63: 737-50(Nov. 1968).

Major deposits of uranium occur in the Jackpile Sandstone, a local and uppermost unit in the Jurassic Morrison Formation, near Laguna, New Mexico. Field and laboratory observations indicate that an organic environment is a critical feature of ore deposition, the major precipitant having been introduced epigenetically and probably derived from decaying vegetable matter. A combination of reduction and sorption probably prevailed to produce high enrichment, followed by formation of colloidal coffinite. Structural controls to ore are not apparent, but sedimentary permeability had an important effect on the distribution of organic decomposition products and ore. Stratigraphic and textural features and lead-uranium ages indicate that the ore was emplaced while the host sandstone was near the surface during the pre-Dakota hiatus; the position of the water table at this time was extremely important to deposition and protection of ore. Either of two sources for uranium appear most likely prior to the Dakota: fluids from Morrison volcanoes, or labile constituents in the Jackpile Sandstone. The preservation of delicate volcanic debris and euhedral quartz bipyramids suggests that volcanism continued through Morrison time and may have been near the deposit area. Fluid emanations from these Morrison volcanoes may have carried uranium upward through structures such as the Woodrow pipe, but more substantial evidence is needed to establish this hypothesis. A more likely source for uranium is in the sediments altered prior to the Dakota. Petrographic studies indicate that the originally arkosic sands were reduced in most places to subarkose or orthoquartzite before or shortly after sedimentation. Traces of uranium present in feldspars, heavy minerals, and volcanic debris which were destroyed prior to the Dakota would have been available for concentration. (auth)

Seismology

6234 (FOA-4-4370) TELESEISMIC RELATIVE LOCATION OF CLOSELY SPACED EPICENTERS. Kogeus, K. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Sept. 1968. 48p. Dep.

A method to determine relative locations of closely spaced epicenters from teleseismic readings is defined. The method was tested on known Bikini events and applied to some events in Kazakhstan during 1965, 1966 and 1967. Statistical confidence measures are computed and sources of bias are discussed. (auth)

6235 SEISMIC TRAVEL TIME ANOMALY DUE TO ANOMALOUS HEAT FLOW AND DENSITY. Horai, Ki-iti; Simmons, Gene (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 73: 7577-88(Dec. 15, 1968).

The effects on seismic travel times of (1) excess temperatures associated with the low-order harmonics of the surface heat flow and (2) excess mass estimated from the high-order harmonics of the Earth's graviational field as determined from satellite orbits are calculated. The results are compared with the data of heat flow and the seismic time delays of Longshot, an underground nuclear explosion in the Aleutians. It is suggested that the thermal field rather than the density of the Earth may be a major cause of the seismic travel time anomaly. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstract 6227.

6236 (ORNL-TM-2399) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS (CANE). Progress Report, July 1–September 30, 1968. Arnold, W. D.; Crouse, D. J. (comps.) (Oak Ridge National Lab., Tenn.). Oct. 29, 1968. Contract W-7405-eng-26. 15p. Dep. CFSTI.

The tritium contamination of oil retorted from Green River oil shale which had been exposed to tritiated water vapor at 85°C in a sealed flask increased with increasing shale particle size. Up to 84% of the tritium was removed from a column of contaminated shale by passing water-saturated air through the column at 95°C. (auth)

6237 FRACTURING WITH NUCLEAR DEVICE WILL RESOLVE UNANSWERED QUESTIONS. Brinkoeter, W. R. (Keplinger and Associates, Houston, Tex.). Oil Gas J., 65: No. 25, 127-32(June 19, 1967).

The use of nuclear explosions to stimulate the production of oils and gases is discussed. Three research projects — Projects Dragon Tail, Gasbuggy, and Rulison — are described. These projects should provide answers to many technological problems relating to nuclear fracturing and should aid in developing nuclear explosions as a practical tool for the oil and gas industries. The use of nuclear explosives in nuclear fracturing is discussed under the following headings: economics, location, burial depth, formation thickness, radioactivity, and political aspects. (R.C.K.)

6238 PROJECT GASBUGGY: STATUS REPORT. Atkinson, Charles H.; Ward, Don C. (USBM, Bartlesville, Okla.). J. Petrol. Technol., 19: 1319-24(Oct. 1967).

Preshot reservoir and production data and programs related to safety, public information, and postshot exploration are discussed. Preshot data revealed that the location selected will afford the opportunity to fulfill the objectives of testing the effectiveness of underground nuclear explosions for fracturing low-permeability reservoirs. The Pictured Cliffs gas reservoir was found to have extremely low permeability and low productivity and the analysis of the site confirmed the predictions. (J.C.W.)

Facilities and Equipment

Refer also to abstracts 6485, 6944, 6948, 6951–6953, 6955, 6956, and 6958–6961.

6239 (AEC-tr-6959) LUBRICATION IN TURBULENT REGIME. Constantinescu, V. N. Translation of Teoria Lubrificatiei in Regim Turbulent, Editura Academiei Republicii Populare Romane, Bucharest, Rumania, 1965. 321p. CFSTI.

Turbulent film lubrication is a subject of increasing importance to engineers, particularly those in the nuclear power field, where liquid metals of low kinematic viscosity are to be used as lubricants in high performance turbomachinery. Turbulent film lubrication is discussed under the following headings: transition conditions from laminar to turbulent flow; influence of turbulence upon the motion of a lubricant layer; lubrication by liquids in the turbulent state; lubrication by gases in the turbulent state; lubrication in the unstable turbulent state; and some extensions of the theory of lubrications in turbulent regime. (R.C.K.)

6240 (CONF-670401-16) DESIGN AND CONSTRUCTION OF A RADIATION LABORATORY. Parrish, Clyde F. (Indiana State Univ., Terre Haute. Radiation Lab.). [nd]. 22p.

From 153rd National Meeting, American Chemical Society, Miami Beach, Fla.

The design concepts for a Radiation Facility consisting of a radioisotope laboratory, counting room, pulsed electron equipment, and a 10,000 Ci of ^{60}Co for an integrated program of radiation chemistry and radiochemistry for both research and instruction at the advanced undergraduate and graduate levels are presented. The pulsed electron equipment and the ^{60}Co source are housed in separate "caves" each with labyrinth entrances so that they may be operated independently. The "caves" have remote handling devices and safety equipment which provides protection for personnel. One of the major objectives of the design has been to minimize maintenance problems. (auth)

6241 (EUR-4057) HIGH-TEMPERATURE IN VACUO MICROHARDNESS MACHINE. Grunspan, D.; Jacques, J.; Bonnet, P.; Grin, M. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 13, 1968. 44p. (In French). Dep.

A new microhardness tester that operates under a vacuum of 5×10^{-6} Torr at high temperatures is described. The electron beam heats at a heating rate, from 20 to 1000° in 120 sec and the cooling rate is 1100 to 300°C in 120 sec. Measurement of the Vickers indents at the temperature of the test is made with a special microscope with long focus lens which produces a 600 magnification. With a capacitive gage, it is possible to measure the rate of penetration of the indents. Examples of the use of the tester are: microhardness curves for four grades of SAP materials between 20 and 500°C; structural transformations in a 2.5 Nb–Zr alloy; and structural transformations of a 12% Cr steel after rapid cooling from 1000°C. (auth)

6242 (K-L-6220) DESIGN OF BATCH DESUBLIMERS. Dunthorn, D. I. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Sept. 19, 1968. Contract W-7405-eng-26. 88p. Dep. CFSTI.

Batchwise desublimation is a frequently used unit operation for removal of uranium hexafluoride or similar compounds from noncondensable carrier gas streams in such processes as volatility recovery of valuable materials from spent nuclear fuels and feed material production for the gaseous diffusion complex. While desublimers have been used since the early days of gaseous diffusion, very little has been published concerning their design. In this report, a theory of desublimation is developed and used as the basis for a stepwise design procedure, which is illustrated through the use of an example design of a desublimer, or "cold trap," for uranium hexafluoride service. A digital computer program forms an integral part of the design method, and a large portion of the report deals with the use of this program, the calculation methods employed in it, recommendations for altering it to conform to specialized applications or different computer facilities, and comparison of program results with data from existing desublimer installations. (auth)

6243 (ORNL-TM-2358) DIFFUSION PROCESS FOR REMOVING TRITIUM FROM THE BLANKET OF A THERMONUCLEAR REACTOR. Fraas, A. P. (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 24p. Dep. CFSTI.

The tritium concentration in the blanket of a thermonuclear reactor is important both from the standpoint of its effect on the capital investment required and from the standpoint of possible embrittlement of the structural material. The size and cost of the system required to keep the tritium concentration to an acceptable level are important from the feasibility standpoint. The high diffusion coefficient for H diffusing through Nb makes it possible to design a tritium removal system for thermonuclear reactors. The proposed system entails tritium diffusion from the Li of the blanket as it circulates through the main heat exchangers built of Nb. These would be operated at about 1800°F and be used to boil potassium for a potassium vapor topping cycle. A stainless steel potassium condenser operating at about 1100°F would serve not only as the boiler for a steam cycle but it would also be designed to concentrate the tritium which would be drawn off as a noncondensable. The incremental cost of the resulting tritium removal system designed to hold the tritium inventory to about 10 kg in a 5000 Mw(t) plant appears to be modest–roughly $4,000,000. (auth)

6244 ABOUT ^{60}Co-THERAPY UNIT "GAMMATRON-3a" (SIEMENS) IN DEPT. OF RADIOLOGY, SAPPORO CITY HOSPITAL. Nanbu, Masatugu; Yokota, Shigeru (Sapporo City Hospital). Shiritsu Sapporo Byoin Ishi, 27: No. 2, 35-48(Jan. 1967). (In Japanese).

The construction and some features of the Gammatron-3a, installed in Sapporo City Hospital are described. It weighs 3.2 tons and the source container can hold up to 3000 curies. The rotary shutter employed is opened by means of a motor and closed by a spring, while the collimators can be opened or closed both by a motor and by hand. The radiation leakage, when the shutter is closed, is less than 0.1 mR/hr. It is provided with television and camera devices, and also with an audio-tension-remover. With the Gammatron, fixed irradiations from any position through all angles of 360°, rotary irradiations from both right and left through 360°, and reciprocating irradiations at any angle of 360° may be accomplished. (NSA of Japan)

6245 BOILER FEED AND CONDENSATE PUMPS FOR THE BEZNAU NUCLEAR POWER STATION. Sulzer Tech. Rev., 50: 98(1968).

The design and operating characteristics of the 3-stage boiler

feed pumps and 4-stage condensate pumps built for the Beznau Nuclear Power Station at Baden, Switzerland are described briefly. (L.C.L.)

6246 SUPERCONDUCTING ELECTRON MICROSCOPE LENS. Dietrich, I.; Weyl, R. (Siemens AG, Munich). pp 210-12 of Proceedings of 2nd International Cryogenic Engineering Conference, Brighton, Eng., 7–10 May 1968. Guildford, Eng., Iliffe Science and Technology Publications Ltd., 1968.

See CONF-680505.

A superconducting sintered niobium stannide lens consisting of a cylindrical coil and two coaxially arranged shielding cylinders was constructed. By using the electrolytic tank method the variations of the characteristic parameters of the device with geometry were investigated on a model with ideal shielding capability. The results were compared with experiments performed on sintered niobium stannide samples prepared under systematically varied conditions. (auth) (UK)

6247 STUDY OF SOME PROBLEMS IN CRYOCABLES USING THE LOW-COST TECHNIQUE OF END-COOLING. Scurlock, R. G. (Univ. of Southampton, Eng.). pp 207-9 of Proceedings of 2nd International Cryogenic Engineering Conference, Brighton, Eng., 7–10 May 1968. Guildford, Eng., Iliffe Science and Technology Publications Ltd., 1968.

See CONF-680505.

Some of the problems associated with cryocables for electrical power transmission can be studied at low cost by the end-cooling of short cable assemblies. The advantages and limitations of this technique for studying thermal and electrical insulation, low thermal conductance supports, a.c. losses, transient overload conditions, current lead-ins, etc., in easily changed cable geometries are discussed. Preliminary experiments are described in which 6-ft dummy cables were end-cooled with liquid nitrogen and liquid helium baths. (auth)

6248 REMARKS ON A NEW SUPERCONDUCTING RECTIFIER. Fasel, R.; Olsen, J. L. (Technische Hochschule, Zurich). pp 204-6 of Proceedings of 2nd International Cryogenic Engineering Conference, Brighton, Eng., 7–10 May 1968. Guildford, Eng., Iliffe Science and Technology Publications Ltd., 1968.

See CONF-680505.

A new superconducting rectifier is described with which the possibilities of obtaining better rectifier characteristics were investigated. (auth) (UK)

6249 SUPERCONDUCTING SOLENOID HAVING A HORIZONTAL AXIS AND A ROOM-TEMPERATURE APERTURE. Meuser, R. B.; Chamberlain, W. H.; Hintz, R. F. (Univ. of California, Berkeley). pp 196-9 of Proceedings of 2nd International Cryogenic Engineering Conference, Brighton, Eng., 7–10 May 1968. Guildford, Eng., Iliffe Science and Technology Publications Ltd., 1968.

See CONF-680505.

A solenoid having a horizontal axis and room-temperature aperture was built. The overall length is 43 in. and the clear bore diameter 4.25 in. It contains 38,770 turns of Nb–48% Ti wire having a 0.015-in. diameter core and a 0.030-in. diameter copper sheath. At the quenching current of 111 A, which is within about 10% of the short-sample value, the current density, based on the coil envelope, is 16.6 kA/cm^2 and the peak field is 65.5 kG. (auth) (UK)

6250 DESIGN AND PERFORMANCE OF A SUPERCONDUCTING DIPOLE MAGNET. Eatwell, A. J.; Goodman, B. B.; Instone, C. S.; Jones, J. E. (British Oxygen Co. Ltd., London). pp 193-5 of Proceedings of 2nd International Cryogenic Engineering Conference, Brighton, Eng., 7–10 May 1968. Guildford, Eng., Iliffe Science and Technology Publications Ltd., 1968.

See CONF-680505.

A 6-cm bore superconducting dipole magnet, capable of producing a uniform transverse field of 2.5 Teslas, was wound from niobium–tin tape. Particular attention was paid to achieving maximum homogeneity of field compatible with minimum complexity of winding. The behaviour under various conditions of excitation was investigated at currents up to and including a maximum quenching current of 2,000 A. (auth) (UK)

6251 DESCRIPTION OF SOME SUPERCONDUCTING MAGNETS AND THEIR ACCESSORIES. Marinet, D.; Leroux, J. M. (Centre d'Etudes Cryogeniques, Sassenage, France). pp 190-2 of Proceedings of 2nd International Cryogenic Engineering Conference, Brighton, Eng., 7–10 May 1968. Guildford, Eng., Iliffe Science and Technology Publications Ltd., 1968. (In French).

See CONF-680505.

Several different types of superconducting magnets as well as their electrical and cryogenic accessories are described. The equipment is used in the laboratory to attain high magnetic fields. (auth) (UK)

6252 RADIATION DIAPHRAGM DEVICE. Nagai, Katumi. (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-27508. Dec. 26, 1967. Filed Mar. 31, 1964.

A radiation diaphragm device is described that has the advantages of producing an irradiation field covering only the lesion and the consequent effective treatment and minimization of radiation injury. A radiation source container is attached to a plurality of diaphragm plates one upon another. Each plate has polygonal or tetragonal openings. The respective parts that form the opening in the middle of the plate can be freely moved and the diaphragm plate itself can be rotated. (NSA of Japan)

6253 RADIATION APPARATUS FOR MEDICAL TREATMENT. Nagai, Katsumi. (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-22619. Dec. 22, 1967. Filed June 9, 1964.

An irradiation device for radiotherapy is described that contains a capsule in which a radiation source is transported between the receptacle and the irradiator. Oil is used as the transfer medium for the capsule which enables a slower rate of travel of the capsule and provides lubrication between the capsule and the conduit. The apparatus is composed of the following: a receptacle which houses a capsule containing a radiation source, a capsule receiving irradiator connected by conduit with the receptacle, an oil line which conveys the capsule from the receptacle to the irradiator and which carries the capsule back to the receptacle, and other oil conveying mechanisms, including lines for the accumulated oil. The capsule is returned to the receptacle by the oil pressure in the tank. (NSA of Japan)

6254 IMPROVED IRRADIATION CAGE FOR MICE WITH HOMOGENEOUS DOSE DISTRIBUTION. Luethy, H. (Buergerspital, Basel). Atompraxis, 14: 488-9(Nov.-Dec. 1968). (In German).

A perspex container for irradiation of groups of small animals (mice) is described which has the following advantages: quick and easy filling of the cage is provided and no struggle for liberation alters the radiosensitivity in an unknown way; the dose differences between the center of the cage and the periphery are compensated by a flattening filter of material with low atomic number; and a dose homogeneity within ±1% is achieved. (auth)

6255 ELECTRON IRRADIATION MACHINE. McCann, John David (to United Kingdom Atomic Energy Authority). U. S. Patent 3,409,798. Nov. 5, 1968. Priority date Aug. 8, 1966, Great Britain.

An electron irradiation machine comprised of an evacuated envelope having a diode, which regulates an ac voltage source, for controlling the electron flow from an emitter cathode to a remote apertured anode is described. The emitter cathode is mounted on a hollow conducting stem and the diode has an anode, which is the stem, and a cathode surrounding the stem. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 6258, 6632, 6641, 6684–6686, 6736–6740, 6742, 6743, 7390, 7395, 7421, and 7435.

6256 (AE-336) CALCULATION OF VOID VOLUME FRACTION IN THE SUBCOOLED AND QUALITY BOILING REGIONS. Rouhani, S. Z.; Axelsson, E. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Oct. 1968. 24p. Dep.

The complex problem of void calculation in the different regions of flow boiling is described in two divisions. The first part includes only the description of the mechanisms and the calculation of the rates of heat transfer for vapour and liquid. It is assumed that heat is removed by vapour generation, heating of the liquid that replaces the detached bubbles, and in some parts, by single phase heat transfer is obtained. An equation is given for the differential changes in the true steam quality throughout the boiling regions by considering the rate of vapour condensation in liquid. Integration of this equation yields the vapour weight fraction at any position. The second part of the problem concerns the determination of the void fractions corresponding to the calculated steam qualities. For this purpose earlier published derivations by Zuber and Findlay were used. This model is compared with data from different geometries including small rectangular channels and large rod bundles. The data covered pressures from 19 to 138 bars, heat fluxes from 18 to 120 W/cm^2 with different subcoolings and mass velocities. The agreement is generally very good. (Sweden).

6257 THERMAL INSULATION OF PRESTRESSED-CONCRETE VESSELS BY METALLIC CLOTH AND FOILS. Arathoon,

J.; Breuille, M.; Lecourt, Y. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 72, 15-20(July-Aug. 1968). (In French).

A calorifuge consisting essentially of metallic sheets was patented in 1961. The principle of the thermal operation of the calorifuge is summarized and applied to the thermal insulation of prestressed concrete reactor vessels. The experimental study of the thermal behavior of the calorifuge was made on cylindrical models, having for the first experiments only one foil. The effects of foil thickness, mean temperature of the foil, variation of the temperature between the two faces of the foil, and the pressure of the carbon dioxide up to an absolute value of 43 bars were studied. Tests were continued on cloths having 14 foils of 10 layers. The fabrication of metallic cloth foils presents no technical difficulties and the setting up of the calorifuge is simple. (J.S.R.)

Isotope Technology

Refer also to abstracts 6091, 6153, 6219, 6240, 6242, 6252, 6253, 6307, and 6629.

6258 (ALO-3632-33) QUARTERLY PROGRESS REPORT OF RESEARCH AND DEVELOPMENT IN A THERMAL INSULATION STUDY, JUNE-AUGUST 1968. Notaro, F.; Grunert, W. E. (Union Carbide Corp., Tonawanda, N. Y. Linde Div.). Contract AT(30-1)-3632. 100p. Dep. CFSTI.

Long-term thermal conductivity tests are currently in progress on four multi-layer systems operating at temperatures from 1400 to 1800°F. Thermal conductivity data and correlation coefficients are summarized for all multi-layer insulation systems studied. Thermal conductivity data (flat plate testing) are presented for four multi-foil insulations for service to 1400°F and four opacified or nonopacified fibrous multi-layer insulations. The methods for correlating thermal performance to temperature and mechanical load (layer density) are discussed. The correlation coefficients based on experimental data are presented. A modified flat plate testing fixture, providing for simultaneous compression of sample and guard in thermal conductivity testing of mechanically loaded samples, is described. A brief flat plate error analysis is presented and an estimated error band on experimental data is given. The penetration analysis is extended to a study of behavior of multi-foil insulation systems in the vicinity of structural supports. Hastelloy-X is considered as a typical structural support material. Effects of penetration size and spacing, as well as insulation thickness and location with respect to the penetration are studied. Results of several analyses are given. The 10,000 hour test on the Hastelloy-X vacuum enclosure specimen (1400°F, 5000 psi exposure conditions) is complete. Plans for final sample analysis have been made. (auth)

6259 (BNL-tr-239) CALCULATION OF THE EFFICIENCY OF A SPHERICAL β-RADIATION SOURCE. Dzhagatspanyan, R. V.; Lyaskin, Yu. G.; Kheifets, L. I.; Kosorotov, V. I.; Mukosey, V. I. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from At. Energ. (USSR), 24: 580-2(1968). 6p. Dep. CFSTI.

An attempt is made to calculate the efficiency of a spherical beta radiation source encased in a cladding of an inactive material of the same density. Dose functions were obtained from Silwerman's formulas, and numerical solutions were determined on a computer. The efficiency of the source is plotted as a function of its radius, while the efficiency of the cladding is plotted as a function of its thickness. (D.L.C.)

6260 (K-Trans-45) PIERRELATTE. Hirsch, Robert; (and others). Translated for Oak Ridge Gaseous Diffusion Plant, Tenn., from Energ. Nucl. (Paris), 9: 479-88(Dec. 1967). 28p. Dep. CFSTI.

An introduction, a summary of the work involved in the startup and operation of the four Pierrelatte isotope separation plants, and a paper on uranium separation in France and in the world are included. A separate abstract was prepared for the latter. (R.C.K.)

For an abstract of the individual paper see: 6261.

6261 (K-Trans-45, pp 7-28) URANIUM ISOTOPE SEPARATION IN FRANCE AND IN THE WORLD. Pecqueur, M. Translated from Energ. Nucl. (Paris), 9: 481-8(Dec. 1967).

An abstract of this paper, prepared from the original language, appeared as NSA 22: 23230. (R.C.K.)

6262 (MLM-1577(tr)) DESIGN OF CLUSIUS-DICKEL THERMAL DIFFUSION COLUMNS. Saviron, J. M.; Beltran, F. G.; Gonzalez, D. Translated for Mound Lab., Miamisburg, Ohio, from An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 61: 249-52(1965). 6p. Dep. CFSTI.

The optimum separation pressures calculated for a thermal diffusion column from experimental measurements can be used for predicting the behavior of another column of different geometry and working temperatures for the same gas. (auth)

6263 (SC-DR-68-809) UNDERWATER SEARCH OPERATION: NIMBUS B/SNAP 19 GENERATORS. (Sandia Labs., Albuquerque, N. Mex.). Nov. 1968. 35p. Dep. CFSTI.

The Sandia underwater search operation which located and photographed two SNAP 19 generators in approximately 300 feet of water off the coast of southern California is described. The generators, part of Nimbus B weather satellite, were lost when the Thorad/Agena vehicle was destroyed. A high-resolution (200 kHz) side-looking sonar and a free submersible with optics were evaluated during the search. (auth)

6264 INVESTIGATION AND DEMONSTRATION OF SINGLE-CRYSTAL AND POWDER DIFFRACTION BY USING ZERO-POWER BETA-EXCITED X-RAY AND ^{55}Fe ISOTOPIC SOURCES. Preuss, Luther E.; Toothacker, William S.; Bugenis, Claudius K. (Edsel B. Ford Inst. for Medical Research, Detroit). Advan. X-Ray Anal., 11: 326-31(1968).

From 16th Annual Conference on Applications of X-Ray Analysis, Denver, Colo. See CONF-670813.

Demonstrable diffraction (powder or single-crystal) with the use of zero-power isotopic sources would provide important data on such systems and may have implications in analysis. One hundred-mCi ^{55}Fe, accelerator- produced, and 4-mCi ^{147}Pm-Cu beta-excited sources were fabricated. Powder-diffraction efficiency with the use of a special diffractometer adapted to these sources is about 10^{-5} (calculated) for the Mn Kα X rays (^{55}Fe) on the NaCl 200 plane. This beam flux at three times natural background intensity was experimentally achieved by using photon spectrometry with proportional counters and multichannel analysis. The LiF diffraction pattern was demonstrated with intensities roughly in agreement with prediction. Lithium fluoride single-crystal diffraction intensity (200 plane) exceeded by 250-fold that of powder. Powder main-peak intensity ($\theta = 31.5°$) produced 9.2 photons per minute at the receiving slit versus 2.3×10^3 events for the single crystal. This single-crystal intensity with 60-sec runs provided a peak resolution of 0.29° full width at half maximum. The first-order Kα, Kβ_1 first order and Kβ_1 second-order beams ($\theta = 31.5°$, 28.3, and 71.6°, respectively) were demonstrated, with 1900 events per minute in the main peak (Kα). X-ray noscreen emulsion was used to study photographic recording on the LiF single crystal with exposures as short as 2.5 hr. A 2-in. diameter camera, newly designed for the ^{55}Fe source, is collecting further emulsion data. The isotopic source is stable, highly predictable in intensity, reliable, and compact. Requiring zero power, it thus has a potential for remote applications. Where its low output can be tolerated, it may hold promise for analysis, especially where its size, weight, and stability are important criteria. Source work points to possible ^{55}Fe improvement in photon output of 10^2 over the source described. Such an increase may make certain special analytical applications feasible. (auth)

6265 BEGINNING OF OPERATION OF AN ISOTOPE BATTERY WITH ^{242}Cm. Atomwirt., Atomtech., 13: 415-16(Aug.-Sept. 1968). (In German).

An isotope battery with 400 mg ^{242}Cm was put into operation at the European Institute for Transuranic Elements in Karlsruhe. This battery is the first of its type in Europe. It has an electrical output of 0.3 W and was designed for a demonstration unit. A schematic diagram and technical data of the battery are given. (J.S.R.)

6266 DIFFUSION IN A TERNARY GAS SYSTEM: APPLICATION TO GAS SEPARATION BY EXTRACTIVE DIFFUSION. Keyes, John Judson Jr. Newark, Del., Univ. of Delaware, 1952. 207p.

Thesis.

The Maxwell-Stefan differential equations for diffusion of three gaseous components are derived, and integrated for the case of axial diffusion in a cylinder. The theoretical development is applied to the enrichment of binary gas mixtures by extraction with counter flowing vapor, which preferentially retards the heavier component, and permits the lighter one to pass. Extensive experimental measurements were made with and without countercurrent flow of vapor. Average deviation of α from theory is 3% for the first case, 10% for the second. Using methanol as extractive agent, 98.5% pure H_2 product is obtained from 45% H_2-N_2 feed. This is considerably better enrichment than reported by Maier in experiments with mass diffusion through porous membranes. Proposals for scale-up to large capacity are given, including a sketch of a suggested production unit. Improvement in over-all performance by addition of an unpacked stripping section is discussed. Application of the theory to separation of ^{3}He-^{4}He and ^{36}Ar-^{40}Ar is made, with emphasis on the utility of the simplified equations for the early and final stages of the cascade. By em-

ploying sufficiently high vapor rate, enrichments equivalent to fifteen or twenty gaseous effusion stages are possible with a single extraction column. It is concluded that countercurrent gaseous extraction is particularly applicable to separations where product purity is the prime consideration; e.g., enrichment of very dilute isotope mixtures. (Diss. Abstr.)

6267 OPTIMIZATION OF SEPARATION PROCESSES. Dickel, G. (Univ., Munich). Isotopenpraxis, 4: 419-24(Nov. 1968). (In German).

A general mass-exchange formula was derived for separation processes, representing the concentration gradient as a function of discharge, the coefficients of which reflect the individual properties (simple process separation factor, circulation flow, etc.) of the separation process. From the optimizing conditions a number of general laws were found to be valid for all separation processes. The dimensions of all separation cascades working under optimum conditions may be determined graphically by a standard diagram. (auth)

6268 DIFFUSION COEFFICIENTS OF RADON (^{222}Rn; ^{220}Rn) IN SOME SOLID MATERIALS. Porstendoerfer, J. (Justus Liebig-Univ., Giessen, Ger.). Biophysik, 5: 248-54(1968). (In German).

A method of measuring the diffusion coefficients of radioactive gases in solid materials is described. The diffusion coefficient of radon was measured in bacon ($D = 1.9 \cdot 10^{-4}$ cm$^2 \cdot$ min^{-1}), paraffin ($D = 8.0 \cdot 10^{-5}$ cm$^2 \cdot$ min^{-1}) and Styropor ($D = 3.4 \cdot 10^{-2}$ cm$^2 \cdot$ min^{-1}). The experiments were carried out with ^{222}Rn and with ^{220}Rn, and the results were compared. (tr-auth)

6269 CONDUCTION FROM A FINITE-SIZE MOVING HEAT SOURCE APPLIED TO RADIOISOTOPE CAPSULE SELF-BURIAL. Easton, C. R. (Douglas Aircraft Co., Santa Monica, Calif.). pp 209-18 of Thermal Conductivity. Flynn, Daniel R.; Peavy, Bradley A. Jr. (eds.). Washington, D. C., National Bureau of Standards, 1968.

From 7th Conference on Thermal Conductivity, Gaithersburg, Md. See NBS-SPEC.PUBL.-302; CONF-671110.

The reentry of a radioisotope heat source and its impact on the Earth's surface may result in burial of the source in soil. Internal heat generation may increase the temperature of the capsule and the surrounding soil enough to melt the soil and initiate capsule self-burial. Analytical studies of heat conduction from a finite, moving heat source were conducted to determine the conditions under which self-burial occurs, the magnitude of self-burial velocity, and the parameters important to self-burial. Configurations studied were a point source, a constant-temperature spherical-shell source, and a finite-line source. For one typical case, self-burial was initiated at a capsule power density of 2.2×10^{-6} W/m^3. The self-burial velocities were on the order of 10^{-5} m/sec or less. The dimensionless groups found to control self-burial are given. (auth)

Materials Testing

Refer also to abstracts 6241, 6258, and 6307.

6270 (HW-62119) CONTROL AND INSPECTION SYSTEMS FOR PLUTONIUM PRODUCTION. Bennett, C. A.; Healy, J. W.; Lewis, W. R.; Work, J. B. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Oct. 1, 1959. Contract W-31-109-eng-52. 287p. Dep. CFSTI.

The Hanford accountability system is described along with a hypothetical system which might control and inspect the working system by an assigned outside group. The study team was assigned for the purpose of the inspection and control of atomic energy facilities to control production under a disarmament agreement. It was to safeguard against increased production of atomic materials so that atomic weapons could not be stockpiled, and to determine what had previously been produced. The problem specifies an inspection system to examine the operating production complex including production reactors, chemical processing and fuel fabrication facilities whose designs, efficiencies and operating parameters were not previously known to the inspectors. (J.C.W.)

6271 INTERNATIONAL CONFERENCE ON STANDARDIZATION OF RADIATION SOURCES. Sul'kin, A. G.; Chervatenko, G. A. Defektoskopiya, No. 5, 85-7(1968). (In Russian).

Standardization aspects of radiation sources are briefly reviewed. Tabular data are presented on iridium sources for γ defectoscopy. The data calculated are in agreement with the recommended dose at 1 m distance from the source. (R.V.J.)

6272 SMALL-DIMENSION BETATRONS AND THEIR USE IN DEFECTOSCOPY. Anan'ev, L. M.; Chakhlov, V. L.; Shtein, M. M.; Yarushkin, Yu. P. Defektoskopiya, No. 5, 60-4(1968). (In Russian).

Descriptions are given of the design and performance of a small dimension betatron used in industrial defectoscopy of 10 to 100 mm thick welding seams with the exposition time of 5 to 35 min and relative sensitivity of 1.5 to 3%. (tr-auth)

6273 DETERMINATION OF THE OPTIMUM MONITORED AREA IN RADIOGRAPHY OF MANUFACTURED GOODS. Elisyutin, G. P.; Maiorov, A. N.; Tyufyakov, N. D. Defektoskopiya, No. 5, 51-6(1968). (In Russian).

The optimum area for radiographic monitoring of industrial products was determined. Data are given for selecting the most effective conditions for minimum handling of each item. Nomograms were constructed showing the optimum γ dose and angle of exposure at a given thickness. Total time for ^{137}Cs and ^{60}Co γ-radiogram for two-dimensional items with 2, 4, and 6 μh thickness was found as functions of the angle. The difference in all optimum magnitudes in all cases did not exceed 10%. (R.V.J.)

6274 PENETRAMETER SENSITIVITY OF COLOR RADIOGRAPHY. Kawamoto, Jun-ichi; Yamamoto, Masago (Toyata Central Research and Development Lab., Japan). Radioisotopes (Tokyo), 17: 523-8(Nov. 1968). (In Japanese).

Items were experimentally investigated to obtain color radiographs of superior quality by ^{192}Ir or ^{60}Co, using color films: the influence of the combination of intensifying screens on the hue and image quality of color radiograph; the conditions of second flashing, which are required to obtain better color contrast; and the penetrameter sensitivities in color radiography. Proper combination of intensifying screens improved the image quality of color radiograph, though the hue was a little changed. The condition to obtain wide range of color change was confirmed to be that the film, half developed in the first bath, was exposed to red, yellow, or green light for 0.2 to 5 sec at 150 cm distance from 150 W lamp. Second flashing procedure, properly practiced, could lead to high penetrameter sensitivity and wide latitude in color radiography. These results are considered to favor the application of color radiography to the nondestructive testing of complex shaped specimens with nonuniform thickness. (NSA of Japan)

6275 PIPELINE RADIOGRAPHY. Data Sheet 600. Chicago, National Safety Council, 1968. 4p. $0.45.

Natural gas and petroleum product pipelines are constructed by fusion welding lengths of pipe together in the field. After this a specified number of them are inspected radiographically. This data sheet discusses the equipment involved in pipeline radiography, the hazards from accidental or careless exposure to ionizing radiation, and the safety equipment that should be provided (area survey meter, ropes, warning lights, and warning signs to help control access to danger zone, sheet lead shielding, dosimeters). Some indications on the qualification of radiographers are indicated. (Occup. Safety and Health Abstr.)

Radioactive Material Handling

6276 (BARC-340) INVESTIGATIONS WITH VERMICULITE AS A FIXED-BED ION EXCHANGE MATERIAL FOR TREATMENT OF LOW AND INTERMEDIATE RADIOACTIVE EFFLUENTS AT TROMBAY. Chandra, Umesh; Brat, Satya; Chinoy, A. R.; Thomas, K. T. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 17p. Dep.

The results of investigations carried out on various samples of vermiculites obtained from different sources in India for the treatment of radioactive liquid wastes from the laboratories of Radiochemistry, Isotope Divisions and the Reactor CIRUS at BARC, Trombay are reported. The best sample, the most suitable pH of the wastes, and the chemical form of the vermiculite mineral for optimum removal of fission-products activity were found and recommended for pilot scale studies. (auth)

6277 (BARC-349) SORPTION OF RADIONUCLIDES BY ATTAPULGITE, MICA (INTERSTRATIFIED), AND VERMICULITE MINERALS. Brat, Satya; Chandra, Umesh; Chinoy, A. R.; Thomas, K. T. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 24p. Dep.

Decontamination performance of some attapulgite, mica (interstratified) and vermiculite type clay minerals of Indian origin has been investigated and compared. Vermiculite, due to its high cation exchange capacity, stability in wide range of pH and its cheap availability was found practicable for treatment of radioactive liquid wastes containing fission products. Cesium selectivity of attapulgite, mica (interstratified) and vermiculite type clay minerals has been determined. The selectivities have been found to increase on heat treatment. The attainment of 10Å structure does

not seem to be the necessary and the only criteria for the mineral to be cesium selective. (auth)

6278 (BNWL-SA-2016) USE OF SYNTHETIC POLYMERS IN SOIL WASTE DISPOSAL SYSTEMS. Carlile, B. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 5, 1968. Contract AT(45-1)-1830. 7p. Dep. CFSTI.

In the safe operation of reactors, it is necessary to have an emergency facility for the disposal of the water from the primary loop in the event of failure or rupture of the loop. Research on the disposal of this waste to the ground showed that activity reductions for cesium and strontium must be of 10^{-6} magnitude. Treatment with low concentrations of alum or sodium sulfate with 0.1 ppM of some nonionic polymers would be effective in reducing particle and radioactivity migration in primary loop waste disposal to the ground. (F.S.)

6279 CONTAMINATION AND DECONTAMINATION TESTS WITH GROUND AND FIRE-POLISHED GLASS SURFACES. Vogg, H. (Kernforschungszentrum, Karlsruhe, Ger.). G-I-T (Glas-Instrum.-Tech.) Fachz. Lab., No. 6, 572-8(June 1968). (In German). (KFK-822).

Comparative measurements with ground and fire-polished taper joints (standard grindings or clear precision joints) showed considerable differences in the values obtained for contamination and decontamination. The tests were carried out with the radionuclides ^{137}Cs, ^{133}Ba, ^{131}I, and with silicone grease irradiated in a reactor. (auth)

6280 CONTAINER FOR A RADIOACTIVE MATERIAL. Inoue, Minoru (to Hitachi Ltd.). Japanese Patent 1968-18000. July 25, 1968. Filed Apr. 4, 1963.

A shielded container for radioactive material is proposed that has the following advantages: complete shielding of the contained radioactive material; easy loading and unloading of the material; and the simple construction. An opening, through which radioactive material is removed or put back, is cut through a part of the wall of the both-ends closed cylindrical container. An outer cylinder slides over the inner cylindrical container. The opening is covered by the cylinder when it reaches a certain position on the length of the container, and the opening is uncovered when it reaches the opposite position. A means is provided for hooking the cylinder at the latter position. (NSA of Japan)

6281 PROSPECTS FOR INTERNATIONAL ARMS CONTROL AND INSPECTION. pp 71-95 of Proceedings of the 1967 Conference, Atomic Industrial Forum, Inc., Chicago, November 6-9, 1967. New York, Atomic Industrial Forum, Inc., 1968. See CONF-671115.

The nuclear nonproliferation treaty drafted by the Eighteen-Nation Disarmament Committee in Geneva is discussed with particular reference to the safeguards provisions. Effects of the treaty on the International Atomic Energy Agency if it were asked to undertake the safeguards inspections are discussed, and the policies and practices of the U. S. Atomic Energy Commission regarding nuclear safeguards are reviewed. (H.D.R.)

Vacuum Engineering

6282 PHYSICAL BASIS OF ULTRAHIGH VACUUM. Redhead, P. A.; Hobson, J. P.; Kornelsen, E. V. London, Chapman and Hall, 1968. 509p. 105s.

The subject is treated under the following main headings: Introduction; physical processes (molecule–molecule and molecule–surface interactions, collision processes in gases, interaction of charged particles with surfaces, interaction of radiation with surfaces, mechanical properties of materials at very low pressures); pressure measurement (general considerations, total pressure gauges, partial pressure gauges); production of ultrahigh vacuum (processing techniques, pumps, examples of ultrahigh-vacuum systems). (UK)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstract 7281.

General Detectors and Monitors

Refer also to abstract 6318.

6283 (CEA-R-3408) SURVEY OF BORON DETECTORS FOR THERMAL NEUTRONS OPERATING IN THE NONPROPORTIONAL REGIME. Vacarie, Jean-Pierre (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1968. 126p. (In French). Dep.

Thesis. Submitted to Univ. of Grenoble, Faculte des Sciences, France.

In gas counters, the alternative of directly detecting (i.e., without using the phenomenon of multiplication) the charges ionized by the reaction $^{10}B(n,\alpha)^{7}Li$, offers many advantages. After examining the ionization phenomenon and deducing the characteristics of low-noise amplifiers, various prototypes are studied. The D.I.N. 5/4, intended for detecting fast neutrons has good isotropic properties thanks to its geometry and good sensitivity. A flat counter (D.E.H. type), with plane and parallel electrodes has a low height of influence for measuring soil moisture. Using the neutron diffraction counter (C.D.N. 2 type) filled under 2 atm and parallelepiped, one can considerably reduce the weight of the goniometer protection, and lightly increase its sensitivity. The results given by the experimental boron coating device have allowed the building of a boron coating counter to be used in current collection. (auth)

6284 (LA-DC-9627) VELA-4 SATELLITE ENERGETIC PARTICLE EXPERIMENT. Singer, S.; Aiello, W. P.; Conner, J. P.; Klebesadel, R. W. (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 16p. (CONF-681017-3). Dep. CFSTI.

From 15th Nuclear Science Symposium, Montreal, Canada.

The Vela-4 satellite energetic-particle experiment consists of a pair of diffused-junction semiconductor detectors for electrons in the energy range 30-600 keV, and a guarded, four-element, solar particle telescope for detecting protons from 0.5 to 100 MeV and alpha particles from 3.6 to 380 MeV in 13 differentially-counted channels. Separation of protons from alpha particles is accomplished by an in-flight particle identifier. Two additional simplified telescopes are used to extend the angular coverage of the primary telescope, and a wide angle, high sensitivity scintillation detector is employed to monitor low intensity solar particle events. The design and operation of these instruments are described. (auth)

6285 (RT/EL-(67)-15, pp 77-96) ^{3}He NEUTRON COUNTER TUBES. Cervellati, R.; Kazimierski, A.; Monaci, P. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). (RT/EL-(67)-19).

The construction of ^{3}He-filled ionization chambers for detection of thermal neutrons is discussed, with special emphasis on the filling of the chambers. The performance characteristics are examined. (B.G.D.)

6286 (SCL-DC-68-27) MINIATURE NEUTRON DETECTOR. Long, W. B. (Sandia Labs., Livermore, Calif.). May 17, 1968. Contract AT(29-1)-789. 9p. (CONF-681017-9). Dep. CFSTI.

From 15th Nuclear Science Symposium, Montreal, Canada.

A miniature neutron detector has been designed to verify the correct operation of a pulsed 14-MeV neutron generator. The detector consists essentially of the following components: a plastic scintillator which converts neutron energy to light; a photomultiplier tube which collects light and converts it into an amplified electrical signal; a power supply adjustable between -750 and -1300 volts; and electronic signal-conditioning circuitry which produces an output while the neutron level exceeds a prescribed value. A light-emitting diode, mounted in the scintillator provides a means of simulating a neutron burst and allows the detector to be independently tested for correct operation. The components are foam-potted in a case measuring 2.4 by 3.8 by 1.5 inches, the entire detector weighs less than 1 pound. (auth)

6287 (UCRL-18118) AUTOMATED DIGITAL THRESHOLD DETERMINATION. Kerns, Cordon R. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 20, 1968. Contract W-7405-eng-48. 10p. (CONF-681017-11). Dep. CFSTI.

From 15th Nuclear Science Symposium, Montreal, Canada.

A system for automatically measuring and displaying the thresholds of many channels of nano-second-speed discriminators is described. It is used in high-energy physics experiments in which the results depend critically upon the stability of the discriminator thresholds. Measurements are made in the dead time between accelerator beam spills. The system includes a programable pulse generator, a 20-channel pulse distribution transformer, and a multichannel coincidence array which is sequentially addressed. Since the distribution transformer is constructed as a throughline, matched-impedance element, it remains permanently connected in the signal lines from the phototubes, and no cables whatever need be disturbed to allow threshold measurement. (auth)

6288 CALCULATIONS OF CURRENT AND VOLTAGE PULSES PRODUCED BY IONIZING PARTICLES IN THIN SEMICONDUCTOR COUNTERS. Iminov, I. (Inst. of Nuclear Physics, Tashkent) Izv. Akad. Nauk Uzb. SSR, Fiz.-Mat. Nauk, 11: No. 4, 42-8(1967). (In Russian).

The time dependence of the current and pulse height from weakly ionizing particles in thin homogeneous semiconductor detectors was determined as a function of energy, electric field intensity, counter characteristics, geometry, and rate of surface recombination. (B.G.D.)

6289 EXPERIENCE WITH CHANNEL-RATIO TECHNIQUE FOR THE QUENCHING CORRECTION IN LIQUID SCINTILLATION COUNTING. Winkler, K.; Schneider, K.-H. (Zentralinstitut fuer Physikalische Chemie, Berlin). Isotopenpraxis, 4: 283-5(July 1968). (In German).

The efficiency of the two-channel method for the quenching correction in liquid scintillation counting was tested with a single scintillator using commercial apparatus. The dependence of the relative counting efficiency on the normalized channel ratio was determined for glass cuvettes and for polyethylene cuvettes with the addition of acetone as quenching solvent. The experimental results showed that the counter loss corrections for ^{14}C by the two-channel method are feasible for devices with only one scintillator with good accuracy. (J.S.R.)

6290 AVOIDANCE OF ELECTROSTATIC CHARGES ON THE PAPER CHROMATOGRAMS OF SUBSTANCES LABELED WITH RADIOISOTOPES IN MEASUREMENTS USING WINDOWLESS COUNTERS. Schmidt, H. (Institut fuer Angewandte Isotopenforschung, Berlin). Isotopenpraxis, 4: 183-4(May 1968). (In German).

It has previously been shown that the counting rate of paper chromatograms can be affected by the inverse voltage between preparation carrier and the counter shield. The electrostatic charge was measured on paper chromatograms with a vibrating condenser electrometer. The results showed that the electrostatic charge of an ^{3}H-labeled chromatogram increases up to 400 mV. The electrostatic charge can be greatly reduced by spraying with a small amount of a graphite suspension. An electrostatic charging of the chromatogram occurs, with the arrangement used, at field strengths which lie at the end of the counter characteristics. On a non-conducting chromatogram it is shown that with increasing flow of methane the charging of the chromatogram was smaller. (J.S.R.)

6291 ORGANIC SCINTILLATORS WITH AN IMPURITY FOR MEASURING THE DOSE RATE OF γ-RADIATION. Vershinina, S. P.; Volosyuk, G. P.; Berlovskii, A. Ya. (Kharkov All-Union Scientific Research Inst. of Monocrystals). Ukr. Fiz. Zh., 13: 1675-8(Oct. 1968). (In Russian).

Introduction of elements with an effective atomic number which is greater than that of air into organic scintillators makes it possible to obtain air-equivalent detectors. Dosimetric characteristics of the mixture were studied consisting of liquid scintillator and chlorobenzene. The investigations showed that the chlorobenzene impurity results in non-proportionality of light yield of the mixture under study depending on the energy of γ-quanta. (auth)

6292 AN OPTIMUM METHOD OF TREATING POISSON'S PULSE SEQUENCE USING SYMMETRICAL SEQUENTIAL ANALYSIS. Drab, Frantisek (Skoda Works, Plzen, Czech.). Jad. Energ., 14: 300-9(1968). (In Czech).

A new method of treating the pulses at the output of nuclear radiation detectors is described. The referred method takes the measurement of parameters of these pulses as a problem of statistical decision, i.e. of testing hypothesis which enables the measurement optimization from the point of view of time and accuracy. In the conclusion the method is compared to present measurement methods and some possible applications are reported. Some prin-

ciples of this method will be applied in the A1 reactor control system. (auth)

6293 OXYGEN GAS-DISCHARGE COUNTER TESLA. Gilar, Oldrich; Pavlicek, Zdenek (Research Inst. for Nuclear Instrumentation, Premysleni, Czech.). Jad. Energ., 14: 294-9(1968). (In Czech).

Design, properties, and operation of oxygen discharge counters Tesla are described. The efficiency and the parameters of oxygen counters are compared to the corresponding parameters of organic-filled and halide-filled counters. (R.V.J.)

6294 SEMIAUTOMATIC APPARATUS FOR MEASURING GEOMETRIC PARAMETERS OF CHARGED PARTICLE TRACKS IN PHOTOEMULSIONS. Voronkov, A. E.; Belovitskii, G. E.; Kolesnikova, L. N.; Marenkov, V. S.; Solov'eva, M. F.; Sukhov, L. V.; Komolov, P. N. Tr. Fiz. Inst., Akad. Nauk SSSR, 42: 62-8(1968). (In Russian).

A semiautomatic apparatus for the measurement of geometric parameters of charged particle tracks in photoemulsions is described. The various constituent parts of the apparatus and their operation are also described. Information on machine processing of numerical data obtained with the apparatus is presented. The apparatus permits the measurement of tracks with a rate up to 150 microns/sec with an accuracy of 0.7 to 1 micron on the X and Y axes and 0.3 microns relative to the Z axis. The apparatus increases production by 5 to 6 times compared with manual methods of measurement. (tr-auth)

6295 FABRICATION AND APPLICATION OF SEMICONDUCTOR RADIATION DETECTORS IN HIGH RESOLUTION NUCLEAR DECAY STUDIES. Sher, Alvin Harvey. Burnaby, British Columbia, Simon Fraser Univ., 1967.

Thesis.

Factors which determine performance of lithium-drifted semiconductor radiation detectors, particularly lithium-drifted germanium detectors for gamma-ray spectroscopy, are discussed in terms of general semiconductor theory. The analysis includes the effects of electronic noise and the statistical effects of radiation-induced ionization and charge collection in semiconductors. The fabrication technique is discussed for obtaining small volume planar Ge(Li) detectors and large volume (totally compensated) Ge(Li) detectors using the lithium-ion drifting process. In the case of detectors of the former type, devices have been fabricated with unusual operating characteristics; excellent resolution has been obtained from such devices at collection fields as low as 15 volts/mm. A new technique for treating the exposed surfaces of Ge(Li) detectors by coating them with a layer of CaF_2 which both lowers detector leakage current and protects the surface from exposure to the ambient is discussed. An estimate of the Fano factor in germanium has been made using Ge(Li) detectors. The value of $F = 0.11 \pm 0.05$ has been obtained, and this result as well as previous ones is discussed in terms of the charge collection efficiency of Ge(Li) detectors, the interaction of gamma-rays with matter and the radiation-induced ionization process, and recent theoretical predictions for the Fano factor. The calibration and use of Ge(Li) detectors for gamma-ray spectroscopy are discussed. Detectors fabricated in this laboratory have been used as gamma-ray spectrometers in high resolution nuclear decay studies. In the study of the decay of ^{56}Co and ^{56}Mn two previously unobserved gamma-rays have been detected at energies of 3119.3 keV and 3598.7 keV; these new transitions result in placing of two levels in ^{56}Fe at energies of 3119.3 keV and 4445.3 keV which have been previously observed only in nuclear reaction studies. The present study, which has included both single Ge(Li) detector measurements and two-parameter coincidence experiments using a Ge(Li) detector and Na(Tl) detector, has confirmed the existence of certain other energy levels in ^{56}Fe and has provided added information on spin and parity assignments to the levels. The nuclear decay study of ^{66}Ge has yielded new results for the levels in ^{66}Ga. A gamma-ray of energy 536.9 keV has been detected for the first time resulting in the placement of a new energy level in ^{66}Ga of this energy. The previously reported gamma-ray of energy 185 keV has been resolved with Ge(Li) detectors into two transitions of energies 181.9 keV and 189.8 keV. The existence of a gamma-ray of energy 515.0 keV has been postulated; more precise values for the energies of the other gamma-rays from the decay of ^{66}Ge have been obtained and a revised decayed scheme has been constructed. The decay of ^{68}Ga has been studied using Ge(Li) detectors and preliminary gamma-ray data obtained. (Disser. Abstr.)

6296 WIDE RANGE RADIATION DETECTOR. Jehle, Robert E. (to Secretary of the Navy). U. S. Patent 3,407,299. Oct. 22, 1968. Filed Feb. 10, 1965.

An apparatus and method for measuring a wide range of ionizing radiation which includes generating a repetitive series of pulses of different durations and each of a voltage amplitude sufficient to energize a GM tube are described. The resultant current pulses emanating from the GM tube are counted in synchronization with the said pulse series. (auth)

6297 COLLIMATOR AND METHOD OF MAKING SAME. Hansen, Carl W. (to Picker Corp.). U. S. Patent 3,407,300. Oct. 22, 1968. Filed Apr. 14, 1966.

A technique for making collimators for use with scintillation counters and low-energy isotopic radiation sources is described. Thin sheets of lead foil are each bonded to themselves as they are wrapped around mandrels. The wrapped mandrels are arranged in a matrix in a body bore. The space between the matrix and the body is suitably filled to bond the matrix in place. The mandrels are then removed to produce the disclosed collimator which has tapered passages of hexagonal configuration. (auth)

6298 SUBATOMIC PARTICLE DETECTOR BY MEANS OF PRODUCING SOLIDIFIED TRACKS IN A LIQUID. Lode, Tenny D. U. S. Patent 3,405,266. Oct. 8, 1968. Filed Dec. 4, 1964.

A particle detector for the detection and measurement of the passages and paths of individual subatomic particles is described. In one form, a liquid at a controlled temperature is placed in an unstable supercooled state by a change in pressure. Preferential solidification then takes place along the paths of charged subatomic particles, thereby indicating these paths. (auth)

6299 THROUGH-FLOW IONISATION CHAMBER. Baron, Henri (to Commissariat a l'Energie Atomique). British Patent 1,137,039. Dec. 18, 1968. Priority date March 28, 1966, France.

A flow-through ionization chamber for measuring the ion content of a gas traversing the chamber is described. It consists of the enveloping electrode at ground potential and a high tension electrode. The measuring electrode contains orifices for entry of the gas. It is used for the continuous monitoring of atmospheric contamination by radioactive gases such as tritium. (W.H.K.)

6300 IMPROVEMENTS IN OR RELATING TO NEUTRON FLUX DETECTORS. Wade, Frederick (to United Kingdom Atomic Energy Authority). British Patent 1,133,789. Nov. 20, 1968. Filed July 22, 1966.

A neutron flux detector of the ionization chamber type is described, having two main ionization chambers, the first sensitive to neutron flux and other radiation and the second sensitive to the other radiation alone. The two chambers are connected together to yield an output representative of the neutron flux alone, allowing the second chamber to compensate for the sensitivity of the first chamber to the other radiation. A plurality of compensation adjusting ionization chambers and a switching arrangement are included in the detector, so that any one or a combination of the compensation adjusting ionization chambers can be switched into the circuit. (UK)

Nuclear Spectroscopic Instrumentation

6301 (CEA-R-3293) DEVELOPMENT OF A GAS-IONIZATION β SPECTROMETER. Le Du, Rene (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). May 1968. 134p. (In French). Dep.

Development of a β-spectrometer is described. This apparatus will have two main objectives: the determination of the nature and the degree of purity of certain β-emitting radioactive substances; and the study of an activity calibration process for β-emitting radioactive sources. (auth)

6302 (CEA-R-3562) GAMMA SPECTROMETER USING A Ge(Li) DETECTOR AND OPERATING SIMULTANEOUSLY AS A PAIR SPECTROMETER AND IN THE ANTI-COMPTON REGIME. Grenier, Gerard; Poussier, Claude (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Sept. 1968. 24p. (In French). Dep.

A description is given of a spectrometer using a Ge(Li) detector which can operate simultaneously as a pair spectrometer and in the anti-Compton regime. The performances are given and compared with those of other similar equipment. (auth)

6303 (CEA-R-3566) α SPECTROMETRY; GRID IONIZATION CHAMBER: IMPROVEMENT OF THE CHARACTERISTICS. Le Du, Rene; Miltenberger, Bernard (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Sept. 1968. 23p. (In French). Dep.

The rise time of the signals obtained with a grid ionization chamber depends on the orientation in the chamber and on the mobility of the ionization components. Grid chambers are fitted with an electronic system which analyses the signals due to the electronic ionization components which are collected on the plate and on the source holder. By obtaining coincidence between these

two signals, it is possible to select paths of any given orientation. Using this principle an electronic collimator was built which does not have the disadvantages of a mechanical collimator for α spectra studies, and which, further, considerably reduces the background of the chamber. Simultaneously with the study of the improvement of α spectra with the device, it was found possible to dissociate the contributions of back-diffusion and of self-absorption phenomena to the activity of an α source. Some results are presented. (auth)

6304 (EUR-4077) SPARK CHAMBER FISSION FRAGMENT DETECTOR. Migneco, E.; Theobald, J. P.; Merla, M. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). July 2, 1968. 18p. Dep.

A study of the properties of a wire-to-plane spark chamber as fission fragment detector discriminating against less ionizing radiation is reported. (auth)

6305 (KFK-778) RECENT PROGRESS IN HIGH PRECISION NUCLEAR SPECTROMETRY WITH SEMICONDUCTOR COUNTERS. Horsch, F.; Meyer, O.; Michaelis, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). July 1968. 15p. (CONF-680906-8). Dep.

From International Symposium on Nuclear Electronics, Versailles, France.

Recent progress at Karlsruhe in obtaining optimum precision in nuclear spectrometry with semiconductor counters is summarized. New electronic components such as an ultra-high precision pulser for nonlinearity correction, digital stabilization and system checkout, and a timing unit which has been designed for spectrometers where optimum energy resolution is of utmost importance are described. Ion implantation techniques are discussed. The characteristics of ion implanted counters are compared with the performance of detectors produced by diffusion or surface barrier techniques. The dependence of window thickness on reverse voltage, ion energy and ion number and the influence of doping concentration and annealing temperature are discussed. New data are given on the performance of the Karlsruhe Ge(Li) anti-Compton spectrometer. A procedure for computer spectrum analysis is sketched very briefly. To illustrate the high precision which is obtained in radiative neutron capture spectroscopy, results are presented for the first excited states in ^{68}Zn. (auth)

6306 (UCRL-Trans-10293) PROCESSING OF DATA FROM A γ SPECTROMETER. Boulanger, Jean-Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated by W. H. Robinson for Univ. of California, Lawrence Radiation Lab., Livermore, from report CEA-R-2991. 63p. Dep. CFSTI.

After briefly recapitulating the principle of the method of least squares, the problems raised by the processing of data contained in a γ spectrum are studied. The measurement of the energy and relative intensity of the γ radiation by means of the abscissa and area of the total-absorption peak, the calculation of the activity of the components in a mixture, and determination of impurities are discussed. Experimental results relating to the systematic testing of the capabilities of the methods used are considered. (auth)

6307 SPECTRAL ANGULAR DISTRIBUTION OF ^{137}Cs γ RADIATION BEHIND CYLINDRICAL STEEL BARRIERS. Gruzien, P. L.; Drabkin, L. A.; Kosarev, L. I. (All-Union Scientific Research Inst. of Tech., Dnepropetrovsk, USSR). Defektoskopiya, No. 5, 48-51(1968). (In Russian).

Descriptions are given of the design and performance of a device for obtaining spectral angular distribution of a narrow beam of ^{137}Cs γ radiation scattered from cylindrical barriers of various thicknesses and configurations. (R.V.J.)

6308 MEASUREMENTS OF FISSION GASES IN AN IN-PILE LOOP WITH Ge(Li) DETECTORS. Kitahara, Tanemichi; Gotoh, Hiroshi; Shirai, Eiji (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo), 5: 596-8(Nov. 1968).

Experiments using lithium-drifted germanium gamma spectrometers for identifying short-lived fission gases released from ceramic fuel materials in a helium-gas cooled high-temperature in-pile loop are described. (W.H.K.)

6309 LOW-BACKGROUND β RAY SPECTROMETER FOR SOLID SAMPLES. Morita, I.; Iwata, Minoru (Kobe Industry Corp., Tokyo). Genshiryoku Kogyo, 14: No. 9, 45-50(Sept. 1968). (In Japanese).

The β-ray spectrometer, capable of energy analysis of feeble β-ray samples, which has been developed jointly by Kobe Industries Corp., National Institute of Radiological Sciences, etc., is described. β-rays pass through a penetrating-type gas flow GM tube, with little energy loss, producing the GM tube output. The whole energy is consumed in a plastic scintillator, producing the scintillator output of a pulse height proportional to the energy. This scintillator output is led to the pulse height analyzer only when the gate is opened by the GM tube output. The features of the spectrometer are the following: obtaining of the spectrum of feeble samples with 1 dpm; easy determination of the peak energy; measurement of samples in the solid state; detection of the contamination of samples. (NSA of Japan)

High Energy Physics Instrumentation

6310 (BNL-12900) DIGITIZED SPARK CHAMBER AND ON-LINE COMPUTER SYSTEMS FOR DOUBLE VERTEX EVENTS. Lindenbaum, S. J. (Brookhaven National Lab., Upton, N. Y.). Sept. 1968. 22p. (CONF-680906-7). Dep. CFSTI.

From International Symposium on Nuclear Electronics, Versailles, France.

A new double V (vertex) magnetic spectrometer system which has been under development at BNL for the past several years is described. The system is suitable for the automatic detection and measurement of the momenta of the charged decay particles from double vertex events and is scheduled to be tested at the AGS this winter and spring. The system contains two multi-particle detecting magnetic spectrometer arms, utilizing spark chamber hodoscopes (i.e., wire chambers) with automatic digitization of spark location, via magnetostrictive readout digitized by scaler readings. The data are handled by a local data handler which stores the raw data in a local computer memory and between AGS pulses (every 2.5 sec) sends a preselected sample to the PDP-6 computer system of the Brookhaven On-Line Data Facility. This on-line data facility equipment is being used by many Brookhaven user groups in a variety of digitized spark chamber and counter experiments and is treated separately. (auth)

6311 (JINR-P13-4134) NUMERICAL ANALYSIS OF THE FIELD OF THE 2-METRE HYDROGEN BUBBLE CHAMBER MAGNET. Doinikov, N. I.; Komarova, S. N.; Simakov, A. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 11p. (In Russian). Dep.

A technique is described for investigating the case of strong iron saturation. The results of the numerical analysis of the stationary field of the 2-meter hydrogen bubble chamber magnet (Laboratory of High Energies, JINR), obtained in the plane-parallel approximation by the net-point method using a BESM-3M computer, are given. (auth)

6312 (SLAC-PUB-511) MIDAS: A MULTILEVEL INTERACTIVE DATA ACQUISITION SYSTEM. Russell, R. D. (Stanford Linear Accelerator Center, Calif.). Oct. 1968. 5p. (CONF-681017-12). Dep. CFSTI.

From 15th Nuclear Science Symposium, Montreal, Canada.

A system is described for using a medium scale computer in real time data acquisition, analysis, and control of high-energy physics experiments utilizing wire spark chambers. (auth)

6313 SOME CRYOGENIC ASPECTS OF THE OXFORD UNIVERSITY-RUTHERFORD LABORATORY 80-cm LIQUID-HELIUM BUBBLE CHAMBER. Bailey, C. A.; Davey, G. (Oxford Univ.). pp 159-62 of Proceedings of 2nd International Cryogenic Engineering Conference, Brighton, Eng., 7-10 May 1968. Guildford, Eng., Iliffe Science and Technology Publications Ltd., 1968.

See CONF-680505.

The bubble chamber, designed for use with the 7-GeV proton synchrotron at the Rutherford Laboratory, contains about 230 liters of liquid helium and is sensitive to minimum ionizing particles over the liquid temperature range 3.1 to 3.8°K. Some of the cryogenic problems associated with the design, construction and operation are described. (auth)

Radiation Dosimeters

Refer also to abstract 6291.

6314 THERMOLUMINESCENT DOSIMETER AND METHOD. (to E. G. and G., Inc.). British Patent 1,136,983. Dec. 18, 1968. Priority date Feb. 15, 1965, United States.

A method for preparing the thermoluminescent element of a thermoluminescent dosimeter is described. The powdered thermoluminescent material is flushed with a dry, inert gas to remove absorbed gases and other impurities and then hot-pressed at an elevated temperature of from 700 to 900°C at a pressure of 30,000 to 125,000 psi. (W.H.K.)

Radiometric Instruments

Refer also to abstracts 6058 and 6219.

6315 DETERMINATION OF THE RATIO OF ASH TO THE WEIGHT OF THE LAYER OF PAPERS BY MEANS OF RADIOMETRIC METHODS OF ANALYSIS. Broquet, C.; Vacher, M. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), Suppl., No. 72, 4-10(July-Aug. 1968). (In French).

The application of the x-fluorescence method to the measurement of the ash rate and layer weight in the paper industry was investigated. The principle of the x-fluorescence method was discussed, and the fluoroscope was described. Measurements made on paper charged with titanium oxide and talc, on non-charged paper, and on a layered paper charged with calcium carbonate were reported. The results showed that this method would give the ash rate with satisfactory precision, reproducibility, and sensitivity. Under certain conditions the weight of deposited layers could also be determined. (J.S.R.)

6316 INNER LAYER DISPLACEMENT MEASURING METHOD AND APPARATUS. Chope, Wilbert E. (to Industrial Nucleonics Corp.). U. S. Patent 3,405,267. Oct. 8, 1968. Filed June 17, 1964.

Design of a beta backscatter system for determining the relative balance of coating applied to opposite sides of a sheet is described. An example of its use is in the production of vehicle tires which consist of a rubber-coated cord fabric. This instrument ensures that the rubber applied to the cord fabric of the tire ply is coated uniformly. (W.H.K.)

6317 METHOD FOR DETECTING COMBUSTION PRODUCTS. Hanyu, Makoto (to Nippon Dry Chemical Co., Ltd.). Japanese Patent 1968-14755. June 21, 1968. Filed Apr. 17, 1965.

A method is described where combustion products, accidentally occurring in the atmosphere, can be detected by means of penetrating beta rays. In a manner similar to that of a mass spectrograph, beta particles from the source are deflected in a semicircular path by a magnetic field, and the detection is placed at an appropriate position. (NSA of Japan)

Miscellaneous Instruments and Components

Refer also to abstracts 6056 and 6976.

6318 (AECL-2702) AUTOMATIC URINALYSER FOR TRITIUM: AEP5216. Osborne, R. V. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1968. 66p. Dep. CFSTI. CAN $1.50.

The concentration of tritium in urine or other aqueous samples may be measured by liquid scintillation counting with this instrument. The user needs no laboratory skill. Urine may be voided directly into the instrument or other samples may be poured in without metering. The minimum sample volume is 20 cm^3. Concentrations of tritium down to 1 $\mu Ci\ liter^{-1}$ may be measured; for body fluids this concentration corresponds to 3.5% of the maximum permissible body burden. Reproducibility is better than 5% and carry over from one sample to the next is less than 1%. The automatic processing of sample and scintillator preparatory to counting takes 50 seconds and samples may be measured at two-minute intervals. Automatic assay of standard and background samples provides a check on the counting and processing systems. Provision is made for manual control of the processing and a check is kept on the availability of liquid scintillator and standard solution.

6319 (BARC-335) PERFORMANCE OF A SINGLE BEAM ATOMIC ABSORPTION SPECTROPHOTOMETER. D'Silva, A. P.; Venkitachalam, T. V. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 21p. Dep.

The performance of a simple atomic absorption spectrophotometer designed to determine trace impurities in high purity materials is described. This instrument operates on the single beam principle, with no facility for scale expansion, but still the limits of sensitivity obtained here are comparable to the detection limits obtained in commercial instruments using scale expansion techniques. A cost estimate has shown that substantial saving in foreign exchange could be made if similar instruments are fabricated here. (auth)

6320 (BNWL-SA-2017) ACOUSTIC HOLOGRAPHY FOR NUCLEAR INSTRUMENTATION. Hildebrand, B. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 6, 1968. Contract AT(45-1)-1830. 28p. (CONF-681101-5). Dep. CFSTI.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

The development of ultrasonic holography for reactor vessel inspection and surveillance is described. The historical development of holography is discussed. (W.H.K.)

6321 (CERN-68-39) A SIX-INPUT OR-GATE. Nanni, F.; Verweij, H. (European Organization for Nuclear Research, Geneva (Switzerland)). Nov. 14, 1968. 14p. Dep.

A six-input fast OR-gate is described. It has been designed to operate with standard signal levels (0 mV = 0, −800 mV = 1). An output fan-out is incorporated delivering four logic outputs (OR) and one complementary logic output (NOR). Reliable operation is obtained from dc up to 150 MHz. The unit, type N 4132, is part of the CERN-NIM compatible nucleonic instrument range. (auth)

6322 (RT/EL-(67)-15) COORDINATION OF THE ACTIVITY IN THE FIELD OF ELECTRONICS AND OF INSTRUMENTATION. Report No. 3, Physics Electronics. Rispoli, B. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 149p. (In Italian and English). Dep.

Separate abstracts were prepared for two of the four papers included in this report. (C.E.S.)

For abstracts of individual papers see: 6285 and 6334.

6323 (UCB-34-P-32-PR-3) MASS SPECTROSCOPY RESEARCH. Progress Report. (California Univ., Berkeley. Dept. of Physics). Oct. 16, 1968. 14p. Dep. CFSTI.

Recent publications are listed and described. Work in progress is briefly described including iodine–xenon dating, plutonium-244 in meteorites, fission-xenon spectra in transuranic nuclides, rare-gas samples from target irradiations, and technical projects. (W.H.K.)

6324 ANALYSIS, DESIGN, CONSTRUCTION, AND VARIOUS APPLICATIONS OF A POLARIZED NEUTRON SPECTROMETER. Kendrick, Hugh. Ann Arbor, Mich., Univ. of Michigan, 1968. 230p.

Thesis.

This dissertation consists of three principal parts. The analysis, design and construction of a polarized neutron spectrometer are described in detail. The facility is used to study an iron-nickel alloy, holmium, chromium and iron. The third part describes a related investigation of Ti_2O_3 and V_2O_3 using unpolarized neutrons. (Disser. Abstr.)

6325 ELECTRON MICROSCOPE OBJECTIVE MADE OUT OF A SUPERCONDUCTING MATERIAL. Stoyanov, P. A.; Artemova, T. V.; Susov, E. V.; Talashev, A. A. Izv. Akad. Nauk SSSR, Fer. Fiz., 32: 928-31(June 1968). (In Russian).

A cryogenic lens is described in which liquid helium is poured into a cryostat containing a superconducting solenoid to create the magnetic field in the electron microscope. A low-temperature cover cooled by evaporated helium surrounds the whole unit. The sample is introduced by means of an intermediate gating chamber. This cryogenic lens was installed for testing in place of the usual objective of an electron microscope. The solenoids were designed to create a field of 15 kOe. At a current of 36 A a field of 14.8 kOe was measured. Various types of superconducting solenoids will be tested with this objective attached to an ordinary electron microscope. (TTT)

6326 LOGARITHMIC-CONVERSION INTEGRATION COMPARISON TYPE PERIOD METER. Kuwabara, Jun (to Japan Atomic Energy Research Inst.). Japanese Patent 1968-17358. July 22, 1968. Filed Mar. 1964.

An open loop is formed by connecting the output of the integration device to the input of the comparison device. A logarithmic reactor-output voltage is applied to the input of the comparison device; and the output voltage of the integration device and the reactor-output voltage are compared in the comparison device. By means of detection of the difference, the output of the integration device is made always to follow the reactor output. The voltage to be supplied to the input of the integration device is obtained by amplifying the difference voltage through the control device. The reciprocal period is measured by the voltage. The system includes a sliding resistor, in conjunction with the indicator of the logarithmic-output recorder; a voltage dividing circuit in which the division ratio is proportional to the power of the ionization current by means of the sliding resistor; and, a smoothing circuit in which the smoothing effect is controlled to be inversely proportional to the square root of the ionization current. (NSA of Japan)

6327 HIGH VOLTAGE INSULATOR FOR NEUTRON GENERATOR. Bergan, Reuben A. (to Dresser Industries, Inc.). U. S. Patent 3,405,275. Oct. 8, 1968. Filed Jan. 4, 1965.

The compact static atmosphere neutron generator for use in radioactivity well logging has a high voltage insulator arranged structurally in a specific manner relative to the source of high energy neutrons and is formed of a material having high mechanical strength characteristics, such as high density, isostatically formed, alumina. The insulator has a generally frustum conical

outer surface and a tapering inner passage to minimize voltage stress concentrations and to provide leakage paths for arc discharges in order to avoid puncturing the material forming the insulator. A sealed enclosure is divided into two compartments, the first compartment being under a substantial pressure and the second compartment being under a reduced pressure. The large end of the high voltage insulator is hermetically sealed adjacent the second compartment, and the small end of the insulator is positioned in the first compartment for supporting a hollow electrode at a point removed from the ion-permeable section thereof. (auth)

6328 RECORDER FOR NMR SPECTRA UNDER PRESSURE. Slonim, I. Ya.; Konovalov, A. G.; Belen'kaya, I. B. (Scientific Research Inst. of Plastics, Moscow). Zh. Fiz. Khim., 42: 2362-3(Sept. 1968). (In Russian).

A recorder for NMR spectral lines under pressure was described. The sample studied is placed in a high-alumina ceramic ampoule. A hydraulic press is used for compression. The recorder is suitable for recording the NMR spectra of nuclei under pressures up to 1000 atm. (tr-auth)

6329 ON THE MAGNETIC MODIFICATION OF beta RAYS EMITTED BY RADIOISOTOPES. A CONTRIBUTION ON THE PROBLEM OF IMPROVED RESOLUTION OF ELECTRON MICROSCOPIC AUTORADIOGRAPHS. I. Zessack, U.; Fromme, H. G. (Univ., Muenster, Ger.). Z. Wiss. Mikrosk., 67: 193-205 (Dec. 1966). (In German).

During the production of autoradiographs in the electron microscope the question arose occasionally to what extent the electron beam could be more concentrated by the application of magnetic fields. It is shown by means of theoretical considerations and calculations the intensity of radiation emitted within a given solid angle in the geometric conditions imposed by the autoradiographic subject, and to what extent the beam can be concentrated by an axial permanent magnetic field. According to the calculations and estimates beam concentration sufficient for current practical applications and therefore effective increase of the resolving power is not possible with the magnetic field of the order of 10^4 gauss at present obtainable. (auth)

6330 LINEAR-OUTPUT, INTEGRATION COMPARISON PERIOD METER. Kuwabara, Jun (to Japan Atomic Energy Research Inst.). Japanese Patent 1968-18513. Aug. 8, 1968. Filed Mar. 28, 1964.

The advantages of the method proposed are the following: measurement of the period by adding factors to the linear output system; elimination of troublesome differentiation and division devices; and suppression of noise voltages near criticality. A closed loop, which is a connection of the comparison, control, multiplication and integration devices (in that order), is connected to the conventional linear output system. Now, e is the output of the control device, n the output of the integration device, and n_0 the quantity proportional to the (reactor) linear output. The output of $e \times n$ or $e \times n_0$, obtained in the multiplication device, is connected to the integration device. The error signal $n - n_0$ is detected in the comparison device, so that n always follows n_0. This signal is amplified through the control device, and e to be supplied to the multiplication device is obtained. The reciprocal period is measured by means of this e. (NSA of Japan)

6331 DETECTOR FOR MEASURING VOIDS IN THE REACTOR CORE. Yusa, Hideo (to Hitachi Ltd.). Japanese Patent 1968-18840. Aug. 5, 1968. Filed Jan. 29, 1965.

A void detector which is very small in size and suitable for narrow spaces between the fuel rods in the reactor core is described. It consists of the over-all cylindrical body; an aluminum cylinder externally shielded; an electrode fixed on the inside of the cylinder; and an electrical wire in its guide tube, fixed in position by an insulating material. The electrical wire is connected to the electrode through aluminum. The void and water is allowed to flow through the cylindrical body, and the signal of voids is given as a change in the impedance. (NSA of Japan)

6332 20 CHANNEL TIME ANALYZER. Sakamoto, Shigeyasu; Nakadoi, Syozo (Tokai Univ., Tokyo). Tokai Daigaku Kiyo Kogakubu, 1968: No. 1, 11-15(Nov. 1968). (In Japanese).

A parallel scaler-type time analyzer has been developed. It was designed for use in neutron diffusion or neutron thermalization experiments. A channel length of the analyzer is variable from 1 to 300 μsec. This analyzer has shown a good stability and a short dead time. (auth)

6333 PULSED NEUTRON GENERATOR WITH VARIABLE POTENTIAL CONTROL GRID. Carr, Barney J.; Carr, Elisabeth H. (to Kaman Corp.). U. S. Patent 3,401,264. Sept. 10, 1968. Filed Mar. 25, 1966.

A portable pulsed neutron generator is described. It is composed of an ion source, a target spaced therefrom including a substance adapted to produce neutrons on impingement of ions thereon, a control grid electrically isolated from and selectively maintained at a potential other than that of the ion source disposed intermediate the ion source and the target, all disposed within a container maintained under a high degree of vacuum. (auth)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 7032 and 7044.

6334 (RT/EL-(67)-15, pp 5-50) ELECTRIC EFFECTS IN THE IONIC BOMBARDMENT OF SEMICONDUCTORS. Gislon, R.; Rispoli, B.; Spoglia, U. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). (In Italian). (RT/EL(67)-16).

The effects of ion bombardment of the electrical properties of semiconductors are studied. A review is first given of the often contradictory data on modifications in electrical properties. Preliminary studies on doped and natural silicon monocrystals bombarded with gas ions of He, Ar, N_2, He + B_2H_6, He + BF_3, and He + PH_3 are also reviewed. The temperature was varied from 200 to 800°C, and the bombardment current from 1 to 50 mA with an irradiation time of one hour. The silicon was of the n type with resistivity of 50 and 200 Ωcm and of the p type with resistivity of 10 Ωcm. The experimental conditions are reported in detail so that the results can be compared with previous studies. Preliminary results on IV characteristics of large-surface diodes and point contact diodes were reported. The temperature appears to have a decisive effect even on the formation of bubbles. The most important phenomenon for the cathode is the erosion caused by the ejection of material. (J.S.R.)

6335 RECOVERY BEHAVIOR OF Si(Li) JUNCTIONS AFTER GAMMA IRRADIATION. Ammerlaan, C. A. J. (Univ., Amsterdam). J. Appl. Phys., 39: 6023-8(Dec. 1968).

An investigation was made into the room-temperature recovery behavior of lithium-drifted p^+-i-n^+ junctions in silicon after irradiation with ^{60}Co gamma rays. In most cases, the effects due to irradiation were detected by measuring the capacity vs reverse voltage characteristics of the junctions. Negative space charge appears to be created by precipitation of lithium donors on irradiation defects. The relaxation time associated with this interaction is determined by a capture radius of $(4 \pm 1) \times 10^{-6}$ cm. In reverse-biased junctions, space charge is neutralized by lithium-ion drift. This compensation process, also observed in lithium-diffused p-n junctions, is characterized by the ionic relaxation time. Expressions, relating both time constants to properties of the basic silicon, are given. (auth)

6336 EFFECT OF NEUTRON IRRADIATION ON THE ACOUSTIC PERFORMANCE OF EVAPORATED CdS FILMS. Duncan, W.; Hutchins, R.; Richter, J.; Stewart, P. A. M. (Glasgow Univ.). J. Appl. Phys., 39: 5987-94(Dec. 1968).

Investigations have been carried out on the effects of neutron irradiation on the insertion loss of evaporated longitudinal CdS transducers operating in the frequency range 0.9-2.0 GHz. The one-way transducer loss was markedly reduced by irradiation and subsequent annealing, and the transducer bandwidth was also increased. Attempts were made to distinguish between the effects produced by thermal neutrons, fast neutrons, and gamma rays. The results suggest that neutron bombardment induces two opposing processes in a transducer. There is a significant improvement in the insertion loss due to the increase in resistivity, and an increase in the loss due to the lattice damage caused by irradiation, which effectively reduces the electromechanical coupling constant. The latter mechanism was investigated in several bulk samples of CdS. The effect of neutron irradiation on the film resistivity was investigated and it was found that the resistivity increased with irradiation. The measured resistivity was found to be a function of the thickness of the film, and this result was interpreted on the basis that the resistivity measured was an average or effective value of the mosaic of amorphous and crystalline CdS in the film, and was probably not a measure of the resistivity of the crystalline CdS. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 6094, 6159, 6404, 6405, 6433, 6434, 6441, 6443–6449, 6480–6483, 6490, 6491, 6502, 6504, 6505, 6524, 6548, 6552, 6555, 6558, 6564, 6565, 6568, 6572, 6580, 6586, 6606, 6607, 6609, 6612, 6617, and 6622.

6337 (A/AC.82/G/L-1183) STATISTICHESKIE PARAMETRY OBMENA TSEZIYA-137 GLOBAL'NOGO PROISKHOZHDENIYA U ZHITELEI ARKTICHESKIKH RAIONOV. (Statistical Parameters of the Metabolism of ^{137}Cs of Global Origin Among Inhabitants of the Arctic Regions). Ramzaev, P. V.; Troitskaya, M. N.; Ibatullin, S. S.; Kolesnikov, V. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1967. 19p. (In Russian). Dep.

The results show the variability of the biological exchange constant of ^{137}Cs on the recovery of adult males with like profession and comparatively similar living conditions. This indicated that the exchange of ^{137}Cs was affected by factors that were related to a series of incidents. Observations published in 1967 on the low recovery included those areas of the constant, observed in the present statistical evaluation of the data. Incongruities were noted in two cases. The statistical evaluation presented can be used for the dosimetry of ^{137}Cs in excretion. (tr-auth)

6338 (AD-669786) ANTIBODY FORMATION BY TRANSFERRED PERITONEAL CELLS AND SPLEEN CELLS OF MICE. I. TRANSFER OF CELLS FROM IMMUNIZED NONIRRADIATED DONORS TO SYNGENEIC RECIPIENTS WITH AND WITHOUT ANTIGEN. Kornfeld, Lottie; Weyzen, Walter W. H. (Naval Radiological Defense Lab., San Francisco, Calif.). Mar. 22, 1968. 46p. (USNRDL-TR-68-39). CFSTI.

Peritoneal cells and spleen cells from LAF 1 mice given 3 intraperitoneal immunizations of sheep red blood cells synthesized hemagglutinins after transfer to x-irradiated syngeneic recipients, either with or without a concomitant injection of antigen. Antibody formation by cells transferred with antigen resembled a secondary antibody response in intact animals. Hemagglutinins appeared rapidly and in high titer. Approximately 50% of the antibodies were resistant to treatment with 2-mercaptoethanol. Antibody formation by cells transferred without further exposure to antigen differed in several respects. Hemagglutinin titers were lower. Throughout the period of observation, only 6 to 25% of the antibodies formed were mercaptoethanol-resistant. In recipients injected with spleen cells, antibodies appeared rapidly, suggesting that mature antibody-forming cells had been transferred. However, in recipients injected with peritoneal cells from the same donors, antibodies were detected only after a delay of several days, which suggested that mature antibody-forming cells had not been transferred. Hemagglutinins were synthesized as well by a suspension containing all types of peritoneal cells as by a fraction consisting almost entirely of lymphoid cells. Recipients of peritoneal cells from donors which had been given either 1 intraperitoneal immunization or 3 intravenous immunizations had no or only low hemagglutinin titers, in contrast to recipients of cells from donors given 3 intraperitoneal immunizations. (TAB)

6339 (BNWL-714, pp 3.1-38) INHALATION STUDIES. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Inhalation studies were performed in dogs to determine the pathological and physiological effects of radioisotope-labeled particles and to determine the internal distribution of these particles. Among the studies reported are: effects of inhaled plutonium-239-labeled plutonium oxides (PuO_2); distribution of inhaled $^{239}PuO_2$ particles in tissues; distribution of inhaled ^{241}Am in tissues; scanning methods for following the distribution of inhaled radioisotopes in tissues; effects of inhaled $^{239}PuO_2$ on antibody formation; excretion of $^{239}Pu(NO_3)_4$ in bile; effects of inhaled $^{239}Pu(NO_3)_4$ on survival; effects of inhaled aerosols containing ^{144}Ce or ^{144}Pm and effects of DTPA on excretion of these radioisotopes; distribution of inhaled uranium ore dust containing ^{238}U, ^{230}Th, and ^{210}Po in tissues; and effects of x radiation on synthesis of lipids in lung tissues of rats. (E.R.B.)

6340 (BNWL-714, pp 4.1-24) SPACE NUCLEAR SYSTEMS STUDIES. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

PLUTONIUM-238—distribution in tissues of dogs and swine following inhalation of labeled plutonium oxide particles
—effects on dogs and rats following inhalation of labeled plutonium oxide particles, effects of particle size on lethal α and γ
—effects on temperature of plant leaves following deposition, pathological α and γ
—solubility of plutonium oxide-incorporated, in gastric juice
PLUTONIUM-239—effects on survival of rats following inhalation of labeled plutonium oxide particles, α and γ
—distribution in tissues of swine following ingestion of labeled plutonium oxide particles
PARTICLES—distribution in tissues of dogs, rats, and swine following ingestion or inhalation
GAMMA RADIATION—dosimetry in swine following ingestion of cobalt-60, performance of implanted thermoluminescent dosimeters for
ATMOSPHERE EXPOSURE CHAMBERS—design of large-particle dispersion device for (C.H.)

6341 (BNWL-714, pp 5.1-26) RADIOELEMENT TOXICITY STUDIES. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

IODINE-131—uptake by thyroid gland of swine, effects of previous dose on
RATS—radiation effects on, following injection of plutonium-238, effects of physicochemical form on pathological α and γ
—radioisotope uptake by, effects of age on cesium-137, iodine-131, and plutonium-238
PROMETHIUM-143—metabolism in swine
PLUTONIUM-237—production by $^{235}U(\alpha,2n)^{237}Pu$ reaction in cyclotron
—radiation dose to bones following injection of, method for calculation of α (C.H.)

6342 (BNWL-714, pp 7.1-26) MOLECULAR AND CELLULAR LEVEL STUDIES. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

OSTEICHTHYES—Salmonidae sp., metabolism of acetates by, effects of environmental temperature on
—Carassium auratus, metabolism in, effects of environmental temperature on
—Cyprinus carpio, metabolism in, effects of environmental temperature on
TESTES—morphology of cells of human, effects of aging or treatment with chorionic gonadotropin on
X-RADIATION—effects on content of mucopolysaccharides in cells of rat intestine
EUMYCOTIA—Neurospora sp., synthesis of proteins in, mechanisms for (C.H.)

6343 (COO-1691-3) ANNUAL PROGRESS REPORT [ON EFFECTS OF URANYL ACETATE ON PROXIMAL TUBULAR FUNCTION IN RABBIT KIDNEY]. (Cincinnati Univ., Ohio). Oct. 1968. Contract AT(11-1)-1691. 24p. Dep. CFSTI.

Acute renal failure was studied in rabbits two days after the intravenous injection of uranyl acetate (0.2 mg uranium per kg body weight). The poisoned animals showed a decreased inulin clearance and even greater inhibition of mannitol and creatinine clearances. This finding implicates back-diffusion of tubular contents as a factor possibly contributing to the observed depression of glomerular filtration rate. Tubular function as measured by Tm_C and Tm_{PAH} showed even more complete inhibition than glomerular function, indicating a cytotoxic effect on the renal tubule. Analysis of transport kinetics in tissues from poisoned animals in vitro permitted the localization of the major lesion in the PAH secreting system at the peritubular membrane. Efflux of PAH from cells into tubular lumen appeared unaffected. In agreement with the reduced PAH transport into cells, yet unchanged efflux from cells, the intracellular accumulation of PAH in vivo was grossly inhibited. Some implications of these findings for the mechanism of attack of uranium on the renal tubule are discussed. (auth)

6344 (COO-1747-1) X-RAY INDUCED SYNTHESIS OF DNA IN POLYTENE CHROMOSOMES. Technical Progress Report. Plaut, W.; Valencia, J. I. Wisconsin Univ., Madison. Dept. of Zoology). Aug. 15, 1968. Contract AT(11-1)-1747. 7p. Dep. CFSTI.

Salivary glands were removed from Drosophila melanogaster; the two lobes from each gland were separated and one used for treatment, the other for control. Following x-irradiation, tritium-labeled thymidine was added to both experimentals and controls. It was observed that x radiation induced synthesis of DNA at a

large number of sites on the chromosomes as manifested by the incorporation of tritium-labeled thymidine. In untreated glands, about 50% of the nuclei showed label incorporation. In glands irradiated with doses above 1000 R, the frequency of labeled nuclei greatly exceeded 50%. It was discovered that salivary gland nuclei cultured as implants in the abdominal cavity of adult females stopped incorporating tritium-labeled thymidine on the seventh or eighth day after implantation and normal chromosome replication was suppressed in these nuclei. It was found that the implanted glands showed an increase in labeling following irradiation in a manner quite comparable to freshly excised glands. Results of these studies indicate that repair replication is not a partial reinitiation of normal synthesis, but a separate process operating independently. (H.L.W.)

6345 (JPRS-45798) SPACE BIOLOGY AND MEDICINE. Translation of Kosm. Biol. Med., 2: No. 2, 1-93(1968). 143p. CFSTI.

Nineteen papers report results of studies on the effects of the environment encountered during space flight on the physiology of man and experimental animals. Data are included on the dangers from radiation during space flight, the effects of weightlessness on spatial orientation, and the effects of biological stress on physiological adaptation of man. The effects of space flight conditions on blood coagulation, the distribution of bone marrow, the cardiovascular system, and the vascular system of the eyes were studied in dogs. A method of forced feeding of test dogs during space flight is described. A method is also described for extracting nutrients from Chlorella culture media. (C.H.)

6346 (N-68-11141) INTESTINAL ABSORPTION OF RADIOIODINE IN RATS EXPOSED TO HYPOXIA (380 mm Hg) AND FOOD DEPRIVATION. Pearson, Peter F.; Anthony, Adam (Pennsylvania State Univ., University Park. Physiology Labs.). Sept. 1967. 45p. (NASA-CR-90307). CFSTI.

Hypoxia effects on gastrointestinal absorption of orally administered ^{131}I and the extent of its influence on circulating and thyroidal iodide levels were investigated. Two experiments were performed using adult male Holtzman rats. In the first, 12 rats were placed in a decompression chamber for 24 hr while 12 controls were kept at ambient pressures. Both groups were fed ad libitum. In the second experiment, 24 rats were deprived of food for 24 hr; 12 of these were then subjected to hypoxia for 24 hr while the remaining 12 were kept at ambient pressure as food-deprived controls. In all instances, 0.2 μc Na ^{131}I was given orally 24 hr before killing the rats. In both experiments, hypoxic rats had more food and ^{131}I remaining in the stomach than ambient pressure controls, indicating hypoxia causes a delay in the movement of gastric food and iodide into the intestine. Food deprivation alone had no effect on gastric or intestinal levels of radioiodide, indicating no appreciable impairment in iodide absorption. Circulating levels of ^{131}I were comparable in control and hypoxic rats despite a lowered intestinal absorption in hypoxic animals. This was partly caused by an hypoxia-induced reduction in urinary excretion of radioiodide. (STAR)

6347 (NP-tr-1690) THE DEVELOPMENT OF MOLECULAR RADIOBIOLOGY, AND SOME CURRENT PROBLEMS. Zimmer, K. G. Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from Strahlentherapie, 134: 161-74 (1967). 12p. Dep. UK.

A discussion of recent work in the field of molecular radiation biology serves to demonstrate its inherent theoretical interest as well as its importance for the solution of urgent practical problems. Emphasis is placed on electron spin resonance studies of free radicals induced by ionizing radiation in biological materials. (auth) (TSS)

6348 (NSJ-tr-97) EXPERIMENTAL STUDIES FOR THE EFFECT OF $^{95}Zr-^{95}Nb$ TO ALBINO RATS. REPORT 1. DISTRIBUTION OF $^{95}Zr-^{95}Nb$ AMONG ORGANS AND AUTORADIOGRAPHIES OF TIBIA FOR SUBCUTANEOUSLY INJECTED ALBINO RATS. Morishige, Toshiko. Translated from Nippon Eiseigaku Zasshi, 21: 306-12(1966). 14p. Dep. JCL $1.60 fs, $0.80 mf.

Zirconium-95 and niobium-95 were quantitatively injected subcutaneously into rats. The animals were sacrificed five hrs, 24 hrs, seven days, 14 days, 28 days, and 63 days after administration. The distribution of $^{95}Zr-^{95}Nb$ in main organs and tissues was determined, and also radioactivities in the urine and in the feces were determined for 60 days after injection. Autoradiograms of tibia for the victims were prepared, using a macro-contact method, in order to observe the location and turnover rate for $^{95}Zr-^{95}Nb$ in the tibia. (auth)

6349 (NYO-3361-11) [EFFECT OF X-RADIATION ON MITOCHONDRIA]. Progress Report, August 1, 1967-July 30, 1968. Bahr, Gunter F. (Georgetown Univ., Washington, D. C.). June 1968. Contract AT(30-1)-3361. 7p. Dep. CFSTI.

Rats were injected with tritium-labeled thymidine for labeling of mitochondrial DNA. A count of mitochondria with and without silver particles was made from preparations of labeled, isolated mitochondria. The number of double and triple grain counts per mitochondrion was found to be unrelated to the volume of the mitochondrion. Livers of rats were homogenized for fractionation of mitochondrial suspensions using the zonal centrifuge. Three fractions were obtained, small, medium, and large. Samples were removed for fixation in formalin and this material was prepared for electron microscopy. The median dry mass of mitochondria of each of the three fractions was calculated using an integrating densitometer. It was found that the DNA content of a mitochondrion was proportional to its dry mass. Conclusions supported a line of reasoning in which cytoplasmic radiosensitivity, as compared to nuclear radiosensitivity, would be considered proportional to the relative volume occupied by mitochondria. A sensitive fluorometer was designed; it is electronically interfaced with an incremental tape recorder and allows instantaneous registrations and computer analysis of unbleached fluorescence intensities in order of micro seconds. It is hoped that this instrument will permit the measurement of the DNA content of individual mitochondria. (H.L.W.)

6350 (NYO-3446-11) RADIOACTIVE FOODCHAINS IN THE SUBARCTIC ENVIRONMENT. Annual Report, August 15, 1967-August 14, 1968. Miettinen, Jorma K. (Helsinki Univ. (Finland). Dept. of Radiochemistry). Contract AT(30-1)-3446. 73p. Dep. CFSTI.

Separate abstracts were prepared for eight sections of this report. (C.H.)

6351 (NYO-3446-11, pp 53-60) ON WHOLE-BODY COUNTER MEASUREMENTS OF POTASSIUM AND ITS BIOLOGICAL HALF-TIME IN SOME MALE SUBJECTS. Rahola, Tua; Suomela, Matti (Helsinki Univ. (Finland). Dept. of Radiochemistry. Institute of Radiation Physics, Helsinki (Finland)).

The measurement of the whole-body content of potassium in man, based on whole-body counting of γ radiation emitted by naturally occurring ^{40}K or after the administration of a tracer dose of ^{42}K, is discussed. (C.H.)

6352 (ORO-2401-14) MATERNAL-FETAL TRANSPORT AND DISTRIBUTION OF ^{59}Fe AND ^{131}I IN HUMANS. Dyer, N. C.; Brill, A. B.; Glasser, S. R.; Goss, D. A. (Vanderbilt Univ., Nashville, Tenn. School of Medicine). [1968]. 9p. (CONF-680607-9). Dep. CFSTI.

From 13th Annual Health Physics Society Meeting, Denver, Colo.

The gestational age of fetuses studied varied from 11 to 22 weeks. Results indicated that the fetal concentration or percent/gram for ^{59}Fe decreased slightly over this developmental interval while the fetal concentration of ^{131}I increased slightly. The critical fetal organ for ^{59}Fe was the liver with about 80% of the ^{59}Fe found in the fetus being in the liver. For ^{131}I, the critical fetal organ was the thyroid, containing 65% of the radioisotope present in the fetus. The relative distributions of the two radioisotopes within the fetus did not vary greatly during the stages studied. A dose calculation based on parameters of this study reinforced the viewpoint that therapeutic use of ^{131}I for a pregnant woman after the 12th to 14th week would be devastating to the fetal thyroid. (auth)

6353 (SGAE-BL-29/1968) REGULATION OF THE SYNTHESIS OF DIFFERENT NUCLEIC ACIDS WITHIN THE CELL CYCLE AND THE INFLUENCE OF IRRADIATION ON THIS SYSTEM. Altmann, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). [1968]. 5p. (CONF-671064-1). Dep.

From Symposium on Biologically Active Nucleic Acids, Bucharest, Romania.

Results are reported from studies on Chlorella pyrenoidosa. Synchronous cell material was obtained using an automatic Chlorella growth apparatus and at different times of the cell cycle the cells were pulse labeled with ^{14}C-guanine or ^{14}C-cytosine. The extraction of nucleic acids was carried out according to the method of Richter and Senger by phenol treatment, and the separation of the different nucleic acids by a modified MAK column method. The radioactivity values showed that at the beginning of DNA synthesis there was no label in the tRNA fraction. It was concluded that the gene loci controlling tRNA-synthesis were located on one or more sites identical with the DNA-synthesis-starting points. Mononucleate Chlorella cells contained about 10^{-12}g DNA, an amount also found for chromatids of higher organisms. It was concluded from the speed of DNA synthesis and the DNA reduplication time, that the total DNA amount must be divided into subunits that can replicate simultaneously. Irradiation of the synchronous cells with low γ doses a certain time before DNA synthesis started resulted in a higher thymidine-kinase activity and also an increased ^{14}C-thymidine-incorporation in DNA. At higher doses (LD_{50}) the DNA-synthesis in Chlorella cells was strongly inhibited and at the

same irradiation dose RNA synthesis showed only small reduction and the pool of free nucleotides remained constant after irradiation. It was concluded that low level irradiation interacts with regulation systems of cells and can lead to a disturbance in metabolism. (auth) (TSS)

6354 (UCB-34-P-114-X-9) RADIOACTIVE TRACER STUDY OF PREDATION ON NATURAL POPULATIONS OF TERRESTRIAL ISOPODS. Progress Report. Paris, Oscar H. (California Univ., Berkeley). July 1, 1968. Contract AT(11-1)-34. 22p. Dep. CFSTI.

Assimilation and retention of γ-emitting radionuclides by terrestrial isopods (Armadillidium vulgare) were studied. The most useful isotopes for tagging isopod populations were found to be ^{59}Fe, ^{85}Sr, and ^{65}Zn. The biological half-life of ^{85}Sr is about 85 days; approximately 80% of ingested ^{85}Sr was assimilated. The biological half-life of ^{65}Zn is about 60 days; approximately 50% of ingested ^{65}Zn was assimilated. About 44% of ingested ^{59}Fe was assimilated. Isopod predators were identified by tagging isopod populations with ^{59}Fe, ^{85}Sr, and ^{65}Zn and then examining carnivores for isotope uptake. Results indicated that the ground cricket, Stenopelmatus fuscus, and the carabid beetle, Pterostichus vicinus, were the most important isopod predators. Stenopelmatus was used for studies of the rate at which predators consume isopods. It was found that the average rate of consumption was six young isopods and 3.5 adult isopods per day. Young isopods were fed ^{85}Sr and adults were fed ^{65}Zn for studies on differential predation. Studies were conducted on isopod mortality in relation to predation. (H.L.W.)

6355 (UCRL-Trans-10237) EFFECT OF IONIZING RADIATION ON THE BIOLOGICAL ACTIVITY OF DESOXYRIBONUCLEIC ACID. Hagen, U.; Kroeger, H.; Schuchmann, L. Translated by Z. F. St-Gallay for Univ. of California, Lawrence Radiation Lab., Livermore, from report AED-Conf. 1366 presented at the Meeting of the German Biophysical Society, Hannover, July 2-3, 1966. 12p. Dep. CFSTI.

Reaction mechanisms involved in the inactivation of in vitro DNA by uv or x radiation were investigated with emphasis on the effect exerted by the rupture of the nucleotide chain on biological activity. The ability of the irradiated DNA sample to act as a substrate for the enzymatic RNA synthesis was chosen as a measure of its biological activity. Calf thymus DNA was incubated with the four nucleotides and RNA-polymerase in a suitable medium containing mg and mn ions together with 2-mercaptoethanol, and the amount of a nucleotide incorporated in RNA following exposure to various doses of radiation was determined. The degree of denaturation induced by the doses of uv radiation used was hardly measurable, but the biological activity of the samples was reduced by half. Irradiation of DNA with 1500 R x radiation reduced the biological activity to 65% of initial value, but this reduction could not be attributed to denaturing alone. It was concluded that damage to nucleotide bases in the DNA strand caused the reduction of the biological activity. (C.H.)

6356 CHANGES OF PREVENTIVE PROPERTIES AND TITRE OF AGGLUTININS IN RABBITS IRRADIATED AND IMMUNIZED AGAINST TYPHOID FEVER. Pogosyan, M. O. (Dept. of Radiobiology, Erevan). Zh. Mikrobiol., Epidemiol. Immunobiol., No. 9, 127-32(Sept. 1968). (In Russian).

The changes of immune properties of the blood serum and of agglutinin titre occurring in rabbits under the effect of single doses of x irradiation and immunization with typhoid vaccine were studied. X irradiation led to a marked reduction of the immune response of rabbit serum and depressed the capacity of these animals for agglutinin production. Triple immunization promoted accelerated and stable restoration of immune properties of the blood serum of irradiated rabbits. The experiments failed to demonstrate any direct relation between the immune properties and the agglutinin titre in the irradiated animals. A depressive effect of ionizing radiation affected more the immune properties of the serum than the agglutinin titre. (auth)

6357 INSTRUMENTAL DETERMINATION OF TRACE ELEMENTS IN PLANT TISSUE BY NEUTRON ACTIVATION ANALYSIS AND Ge(Li) GAMMA-RAY SPECTROMETRY. Haller, William A.; Rancitelli, Louis A.; Cooper, John A. (Battelle Memorial Inst., Richland, Wash.). J. Agr. Food Chem., 16: 1036-40(Nov.-Dec. 1968).

By use of neutron activation and a large-volume high-resolution Ge(Li) detector, the practicality of determining the concentrations in plant tissue of 15 elements — Mn, K, Cu, Na, As, Br, P, Rb, Cr, Fe, Hg, Se, Zn, Cs, and Co — was demonstrated. This instrumental method, which requires no chemical or ashing manipulation, eliminates many inherent errors associated with chemical determinations. The samples are freeze-dried, neutron-activated, and analyzed by Ge(Li) gamma-ray spectrometry. The resulting spectra are reduced by standard techniques in which the corrected counts are compared to a system of standards to obtain elemental concentrations. (auth)

6358 INFLUENCE OF OXYGEN INHALATION ON THE RESPIRATION AND OXIDATIVE PHOSPHORYLATION OF LIVER MITOCHONDRIA IN IRRADIATED ANIMALS. Shamrai, E. F.; Baran, L. A.; Dzyubko, N. Ya.; Sudarikova, L. G. (Kiev Roentgen-Radiological and Oncological Inst.). Byull. Eksp. Biol. Med., 66: No. 10, 41-4(Oct. 1968). (In Russian).

The influence of oxygen inhalation on tissue respiration and oxidative phosphorylation of liver mitochondria was studied after local irradiation of the liver and after whole-body irradiation. All figures showed a tendency towards a decrease, but the rate of decrease depended on the method of irradiation and on the dose given. A more marked decrease was seen after local irradiation of the liver in rabbits with a dose of 6240 R. Dynamics of these changes after whole-body irradiation depended on the irradiation dose. The lowest figures of respiration and oxidative phosphorylation were seen after whole-body irradiation of rats on the 14th day (dose – 600 R) and on the 8th day (dose – 900 R). Inhalation of oxygen did not prevent a drop in respiration and oxidative phosphorylation (change in the rhythm remained the same), but the degree of decrease was much less pronounced. (auth)

6359 SYSTEMIC ABSORPTION OF ^{210}Po INHALED IN CIGARETTE SMOKE. Little, John B.; McGandy, Robert B. (Harvard Univ., Boston). Arch. Environ. Health, 17: 693-6(Nov. 1968).

The kinetics of the change in the concentration of ^{210}Po in the peripheral blood of six cigarette smokers was studied up to 89 days after sudden complete cessation of smoking. Circulating ^{210}Po levels declined an average of 14% after three to four days, and 20.5% after 11 to 14 days. The results indicate that a major fraction of the isotope inhaled in cigarette smoke is absorbed directly into the blood stream. (auth)

6360 HEMATOLOGICAL DATA FOR THE PIG UTILISABLE IN RADIOBIOLOGY. LIFE SPAN OF ERYTHROCYTES. Vaiman, M.; Dubiez, R.; Colson, X.; Nizza, P. (Laboratoire-Etable de Radiobiologie Appliquee, Jouy-en-Josas, France). Int. J. Appl. Radiat. Isotop., 19: 845-51(Dec. 1968). (In French).

An attempt was made to determine both the half-life of autotransfused chromium-51 labeled red cells and their life-span using selenium-75 labeled methionine. For swine between 5 and 7 months of age, weighing about 65 kg, the apparent half-life of red cells was found to be 15 ± 2 days and their mean life-span 86 ± 4 days. (INIS) (UK)

6361 EFFECTS OF K, Rb, DIAMOX, AND ALDOSTERONE ON ^{86}Rb RETENTION IN THE RAT. Chertok, Robert J.; Lake, Suzanne; Hitchman, Jack W. (Univ. of California, Livermore). Health Phys., 15: 519-26(Dec. 1968).

Potassium, rubidium, Diamox(acetazolamide), and aldosterone have been reported to have direct effects on the renal excretion of potassium. Their effects on the retention and distribution of rubidium were therefore studied by whole-body counting of rats intraperitoneally injected 24 hr earlier with ^{86}Rb Cl. The treatments were begun after the initial counting. After the rates of loss of ^{86}Rb had been established, the organs were removed and counted with a scintillation counter. The ^{86}Rb initially injected in the control animals was reduced to 50% in 9.5 days. In the animals that received 100 mM KCl or 100 mM RbCl in the drinking water, or 30 mg Diamox or 30 μg d-aldosterone injected intraperitoneally daily, the initial amounts of ^{86}Rb were reduced to 50% in 5.2, 5.6, 7.4, and 8.8 days, respectively. The liver and spleen contained the most ^{86}Rb on a wet weight basis. Distribution of ^{86}Rb was altered only in those rats receiving RbCl as a treatment. The brain and muscle appeared to contain more ^{86}Rb, while the liver contained less, than the controls. (INIS) (UK)

6362 EFFECT OF ENVIRONMENTAL TEMPERATURE AND POTASSIUM CONSUMPTION ON ^{137}Cs METABOLISM IN THE RAT. Mahlum, D. D.; Sikov, M. R. (Battelle Memorial Inst., Richland, Wash.). Health Phys., 15: 541-3(Dec. 1968).

Both environmental temperature and potassium consumption have been implicated as factors influencing the retention of exogenous cesium in human populations and in experimental animals. It has been suggested that lowered environmental temperature exerts its effect by increasing the consumption of potassium, but this had not been experimentally verified. In order to test this hypothesis three groups of female rats were housed at room temperature (22° ± 1.5°C) and three groups at 4° ± 1°C. Diets were prepared by supplementing a commercial low potassium diet with potassium acetate in a solution of 0.1% purified agar. The animals at 4°C were fed 30 g/day and those at 22°C 15 g/day.

Sufficient potassium was added to provide a daily intake of 0.74, 54, or 108 mg, independent of environment. The rats were conditioned to their respective environment and diet for 1 week prior to cesium-137 administration and maintained under those conditions for 18 days after injection. Fifty μCi of ^{137}Cs, as the chloride, were injected intraperitoneally and the radioactivity remaining in the animals assayed in a whole-body counter at several times after injection. At the completion of the 18-day retention study the animals were killed and the tissues analyzed for their radioactivity. The specific effects of potassium intake and environmental temperature on ^{137}Cs retention were in good agreement with previous studies, although the data indicated an effect on ^{137}Cs retention beyond that attributable to altered potassium consumption. It seems likely that an alteration in metabolic rate with temperature may be involved. (INIS) (UK)

6363 SOME ASPECTS OF THE EFFECTS OF AGE AND OF CALCIUM INTAKE ON ^{90}Sr METABOLISM IN MAN. Spencer, Herta (Veterans Administration Hospital, Hines, Ill.); Samachson, Joseph; Hardy, Edward P. Jr.; Rivera, Joseph. Contract AT(11-1)-1231-41. Health Phys., 15: 499-504(Dec. 1968).

A comparison of some aspects of ^{90}Sr metabolism of young adults and of persons of the older group was made. These studies were performed during both low and high calcium intake under constant dietary conditions. The data indicate that age and calcium intake affect the discrimination between strontium and calcium by the body. The usefulness of the Observed Ratios (O.R.) of urine/diet and of stool/diet for the calculation of the ^{90}Sr content of the diet in the two age groups during different dietary intake levels of calcium is discussed. (INIS) (UK)

6364 CYTOTOXIC ANTIBODY RESPONSE TO SKIN ALLOGRAFTS IN CALVES: EFFECTS OF EXTRACORPOREAL IRRADIATION OF LYMPH. Joel, D. D.; Chanana, A. D.; Cronkite, E. P.; Schiffer, L. M. (Brookhaven National Lab., Upton, N. Y.). Proc. Soc. Exp. Biol. Med., 129: 483-6(Nov. 1968).

The cytotoxic antibody response to skin allografts was examined in calves which received continuous extracorporeal γ irradiation of thymic duct lymph (ECIL) for up to 28 days. In 3 calves, which maintained posterior skin grafts until ECIL was discontinued, the antibody response was markedly depressed. Following the termination of ECIL cytotoxicity of the sera increased. It was concluded that the antibody response is propagated throughout the body by radiosensitive cells entering the blood via efferent lymphatics. (auth)

6365 INFLUENCE OF THYMUS CELLS ON ERYTHROPOIESIS OF PARENTAL MARROW IN IRRADIATED HYBRID MICE. Goodman, Joan Wright; Shinpock, Sarah G. (Oak Ridge National Lab., Tenn.). Proc. Soc. Exp. Biol. Med., 129: 417-22(Nov. 1968).

Living parental thymus cells injected into heavily x irradiated F_1 hybrid recipients augmented erythropoiesis resulting from transplanted bone marrow from the same, but not the second, parental strain. The augmentation increased as parental thymus cell dose was increased. Thymus cells alone, regardless of origin, gave rise to no erythropoiesis. When recipient spleen weight, eight days after marrow transplantation, was used as a criterion of marrow growth, the data for parental cell doses 4×10^7 and above paralleled those from ^{59}Fe-uptake studies in the same mice. Parental thymus cells were effective even when administered one to two days before or after the marrow transplant. Viable F_1 hybrid thymus cells produced a much smaller, but significant augmentation in the same parent-to-F_1 hybrid combination, one in which poor growth of marrow is well documented. When thymus cells, either parental or F_1 hybrid, were heavily irradiated (10,000 R), only a very small, apparently nonspecific augmentation was seen. (auth)

6366 INFLUENCE OF IONIZING RADIATION ON INTENSITY OF METHIONINE-^{35}S INCLUSION INTO SOLUBLE PROTEINS OF MUSCLES. Sukhomlinov, B. F.; Kapis, M. V. (Lenin State Univ., Lvov). Ukr. Biokhim. Zh., 40: 398-403(1968). (In Ukrainian).

The influence of different doses of x radiation (300, 600, and 1000 R) on rabbits was studied. Electrophoretic characteristics of soluble proteins of muscles and uptake of methionine-^{35}S into separate fractions of soluble proteins of skeletal muscles were measured. In the electrophoretic spectrum of muscle soluble proteins of intact rabbits seven fractions were found, identical to the mobility of proteins of blood serum. One fraction (nonidentified) was specific only to muscular proteins and was located in the zone between β_2- and γ-globulins. X irradiation of animals caused disturbance of the percentage ratio and intensity of methionine-^{35}S uptake by separate protein fractions identical to α- and γ-globulins, and the non-identified fraction which was comparable to the radiation dose. These disturbances were most pronounced during the first days following irradiation of animals with a dose of 1000 R. (auth) (TSS)

6367 RADIATION RESPONSES OF EMBRYONAL AND SV40 TRANSFORMED HAMSTER CELLS IN CULTURE. Kouri, R. E.; Coggin, J. H. Jr. (Univ. of Tennessee, Knoxville). Proc. Soc. Exp. Biol. Med., 129: 609-20(Nov. 1968).

The mechanisms of virus-host cell interaction resulting in the transformation of normal cells to neoplastic cells was examined in embryonal hamster cells in cultures. Recent studies demonstrated that exposure of primary hamster embryonic cells to 150 R of x irradiation prior to infection produced a 15- to 50-fold increase in the number of transformed clones when compared with unirradiated controls. Radiation alone under these conditions did not produce transformed cells. Characterization of the radiation responses of normal embryonal cells in culture is fundamental to understanding the role of irradiation in sensitizing these cells to transformation by SV40 virus. Results obtained in the investigation of several parameters of radiation induced changes in normal hamster cells in culture are presented. A parallel study was conducted on the radiation response of SV40 transformed isogenic hamster cells to define potential viral induced changes that may exist. (auth) (TSS)

6368 CHANGES IN LYMPHATIC BED OF GLOSSAL MUCOUS MEMBRANE IN ACUTE IRRADIATION SICKNESS IN DOG. Kolesov, M. A.; Bakanskaya, V. V. (Grodno State Medical Inst., USSR). Arkh. Anat. Gistol. Embriol., 52: 63-4(1967). (In Russian).

The state of acid mucopolysaccharides of the main connective substance of the solid and soft tissues in animal cerebral cortex and spinal cord during acute radiation sickness was studied using 22 mongrel dogs exposed to γ radiation of 239 R/min, with total dose of 350, 650, and 900 R. A sharp increase in mucopolysaccharides content occurred during the first hours following exposure, with a sharp drop the next day, and complete disappearance after 3 to 5 days. This was accompanied by considerable increase of hyaluronic acid in the subarachnoid space of the brain during first day, followed by complete disappearance. Thus, it was concluded that irradiation affected the permeability of the blood-brain barrier and of the brain tissues. (R.V.J.)

6369 EFFECT OF INTERNAL IRRADIATION FROM ^{32}P ON THE QUANTITY OF DNA AND THE MITOTIC INDEX OF THE REGENERATING RAT LIVER. Turcu, Gr.; Dimoftache, C. (Laboratorul de Biofizica, Bucharest). Stud. Cercet. Fiziol., 13: 255-9(1968). (In Rumanian).

The modifications of mitotic activity and synthesis of DNA, caused by internal irradiation from 2 μCi of ^{32}P/gram of body weight were studied during experimental hepatic regeneration in the rat. The radioactive substrate was injected 24 hr before partial hepatectomy. Mitotic activity and DNA synthesis were determined 24, 28, and 48 hr after hepatectomy. The results indicated that DNA synthesis was slightly inhibited 24 hr after hepatectomy and the mitotic index was sharply decreased 28 hr after hepatectomy. (tr-auth)

6370 HISTAMINE RELEASE FROM RAT PERITONEAL MAST CELLS: INHIBITION BY COLCHICINE AND POTENTIATION BY DEUTERIUM OXIDE. Gillespie, Elizabeth; Levine, Robert J.; Malawista, Stephen E. (Yale Univ., New Haven). J. Pharmacol. Exp. Ther., 164: 158-65(Nov. 1968).

Colchicine and other compounds known to alter the organization of the mitotic spindle were examined for their effects on histamine release from rat peritoneal mast cells. Pretreatment of the cells with colchicine in vitro decreased histamine released induced by either compound 48/80, polymyxin B, or reserpine but not that induced by n-decylamine. The degree of inhibition of release by 48/80 depended on both the time of pretreatment and the concentration of colchicine used. Inhibition, once established, remained unchanged for at least 2 hr after removal of colchicine from the medium. Vinblastine, demecolcine, and griseofulvin also inhibited histamine release by 48/80. Replacement of 35% of the H_2O in the medium by D_2O resulted in potentiation of histamine release by either 48/80, polymyxin B, or reserpine. D_2O, itself, at higher concentrations (40 to 90%) caused histamine release. This effect was inhibited by colchicine. It is suggested that colchicine, demecolcine, vinblastine, griseofulvin, and D_2O all act by altering the degree of organization of cytoplasmic structural elements (possibly microtubules) and that these elements might be involved in mast cell degranulation. (auth)

6371 EFFECT OF DEUTERIUM OXIDE ON THE CULTURING OF PENICILLIUM JANCZEWSKII. III. ANTIFUNGAL ACTIVITY OF FULLY DEUTERATED GRISEOFULVIN. Nona, D. A.; Blake, M. I.; Crespi, H. L.; Katz, J. J. (Univ. of Illinois, Chicago. Argonne National Lab., Ill.). J. Pharm. Sci., 57: 1993-5(Nov. 1968).

The in vitro antifungal activity of fully deuterated, partially deuterated, and protiogriseofulvin was compared. The antibiotics were evaluated by plate assay with Microsporum gypseum (ATCC 14683) as the test organism. A statistically significant enhancement in antifungal activity was observed in zones of inhibition when fully deuterated griseofulvin was compared with partially deuterated and protiogriseofulvin. No significant difference was apparent in a comparison of biological activity of partially deuterated and ordinary griseofulvin. The enhanced antifungal activity demonstrated by fully deuterated griseofulvin may be due to an increased efficiency of action. The antifungal target site may involve the metabolism of a C–D bond directly or indirectly. Since C–D bonds are generally more stable than C–H bonds, the increased stability of the molecule may alter the rate of griseofulvin metabolism by the fungus. (auth)

6372 CHANGES IN ALDOLASE ACTIVITY AS A RESULT OF IRRADIATION BY X-RAYS AND EMBYTOL EFFECT. Savits'kii, I. V.; Musiiko, V. O. (Pirogov Medical Inst., Odessa). Ukr. Biokhim. Zh., 40: 394-7(1968). (In Ukrainian).

The aldolase activity of the brain of rabbits was investigated under conditions of x irradiation and embitol administration. Total single irradiation of animals caused changes in the aldolase activity. The typical feature of these changes was phase deviations towards both relaxation and intensification of the activity. Embitol caused fluctuating changes of the aldolase activity. A combined effect of x-rays and embitol did not cause a summation of the effect of x rays and chemical influence on the aldolase function. This is one of the corroborations of non-uniformity of the mechanisms of these agents' action. (auth) (TSS)

6373 STUDIES ON THE INHIBITION OF INTESTINAL ABSORPTION OF RADIOACTIVE STRONTIUM. VIII. THE EFFECT OF ALGINATE-CONTAINING DIETS ON WATER METABOLISM. Waldron-Edward, D. (McGill Univ., Montreal). Can. Med. Ass. J., 99: 986-92(Nov. 23, 1968).

In cases of acute strontium poisoning, previous studies have shown that alginates are a valuable antidote in human subjects and in animals. In chronic strontium poisoning, long-term administration of alginates would be essential. For this reason and because of the current wide use of non-absorbable filling agents in weight control, studies of water metabolism following alginate administration were undertaken. In the present study, the changes in water metabolism in rats following the feeding of alginates has been compared with the changes following the feeding of other high-bulk, hygroscopic and hypertonic food additives. Sodium alginate, either hydrated or dry, fed to rats, alters the normal demands for drinking water. Considerable quantities of water are excreted by the feces. Dry sodium alginate is hydrated in the gut and produces feces with a moisture content similar to that following the feeding of pre-moistened alginate and other hygroscopic bulky dietary additives. Urine volume, pH and Na^+ output rise sharply; the specific gravity is low. It is concluded that calcium alginate may be preferable for long-term administration because it causes very little change in water intake, urine pH or Na^+ output, and the urinary volume and specific gravity remain within normal limits. (auth) (Canada)

6374 CYTOCHEMICAL METHOD FOR SELECTIVE INTRACELLULAR DAMAGE WITH A RUBY LASER. Tsou, K. C. (Univ. of Pennsylvania, Philadelphia). Life Sci., 7: 785-90(Aug. 1, 1968).

A cytochemical method is presented for selective intracellular damage with a ruby laser by the use of 5-iodoindoxyl derivatives as hydrolytic in vivo substrates, and it is illustrated with the use of 5-iodoindoxyl phosphate on two types of cells. When 5-iodoindoxyl phosphate was added to the incubating media containing Hela cells or Glioma-26 cell culture, blue and purplish granules were seen 20 to 30 min later in some cells. The cytoplasmic staining could be either lysosomes or cytolysosomes (or autophagic vacuoles) since the incubating conditions favored enzymatic hydrolysis due to acid phosphatase rather than to alkaline phosphatase. The laser energy used was 110 to 150 J and the cross-section of the beam 1 μ. The effect of such laser damage was visible only where the dye accumulated and not where the dye had not been present. Thus, a nucleolus of a Hela cell could be seen as purplish-blue dots, and upon irradiation the nucleolus almost exploded. In other sites within the nucleus or in nonstained Hela cells, the effect was not perceptible. It was not possible to decide whether the cells were viable after the treatment. When the energy used was 105 J, the amount of damage, as judged by the size of the damaged spot, was qualitatively proportional to the amount of dye deposited. Calibration should be possible to predict a correlation between the laser energy and the amount of dye deposited. Intracellular damage of cytolysosomes can be selectively achieved with this novel approach. (BBB)

6375 PHAGOCYTOSIS OF INHALED PLUTONIUM OXIDE-^{239}Pu PARTICLES BY PULMONARY MACROPHAGES. Sanders, C. L.; Adee, R. R. (Battelle Memorial Inst., Richland, Wash.). Science, 162: 918-20(Nov. 22, 1968).

Pulmonary macrophages and plutonium particles were removed by washing the lungs of rats that had inhaled plutonium oxide-^{239}Pu. A significant amount of plutonium was found in multiple washings of the same lung. The removal of toxic particles by washing is of potential therapeutic value. Particles were phagocytized by macrophages during the first three hrs and retained within these cells for up to 25 days. Nearly all particles in washings were found in macrophages after the second day. The percent of macrophages with engulfed particles increased with increasing amounts of plutonium deposited in the lungs. The ability of pulmonary macrophages to rapidly phagocytize and retain plutonium particles deposited in the lungs was shown. (auth)

6376 CELL TO CELL INTERACTION IN THE IMMUNE RESPONSE. I. HEMOLYSIN-FORMING CELLS IN NEONATALLY THYMECTOMIZED MICE RECONSTITUTED WITH THYMUS OR THORACIC DUCT LYMPHOCYTES. Miller, J. F. A. P.; Mitchell, G. F. (Walter and Eliza Hall Inst. of Medical Research, Melbourne). J. Exp. Med., 128: 801-20(Oct. 1, 1968).

An injection of viable thymus or thoracic duct lymphocytes was absolutely essential to enable a normal or near-normal 19S hemolysin-forming cell response in the spleens of neonatally thymectomized mice challenged with sheep erythrocytes. Syngeneic thymus lymphocytes were as effective as thoracic duct lymphocytes in this system and allogeneic or semiallogeneic cells could also reconstitute their hosts. No significant elevation of the response was achieved by giving either bone marrow cells, irradiated thymus or thoracic duct cells, thymus extracts, or yeast. Spleen cells from reconstituted mice were exposed to anti-H2 sera directed against either the donor of the thymus or thoracic duct cells, or gainst the neonatally thymectomized host. Only isoantisera directed against the host could significantly reduce the number of hemolysin-forming cells present in the spleen cell suspensions. It was concluded that these antibody-forming cells were derived, not from the inoculated thymus or thoracic duct lymphocytes, but from the host. Thoracic duct cells from donors specifically immunologically tolerant of sheep erythrocytes had a markedly reduced restorative capacity in neonatally thymectomized recipients challenged with sheep erythrocytes. These results suggested that there are cell types, in thymus or thoracic duct lymph, with capacities to react specifically with antigen and to induce the differentiation, to antibody-forming cells, of hemolysin-forming cell precursors derived from a separate cell line present in the neonatally thymectomized hosts. (auth)

6377 CELL TO CELL INTERACTION IN THE IMMUNE RESPONSE. II. THE SOURCE OF HEMOLYSIN-FORMING CELLS IN IRRADIATED MICE GIVEN BONE MARROW AND THYMUS OR THORACIC DUCT LYMPHOCYTES. Mitchell, G. F.; Miller, J. F. A. P. (Walter and Eliza Hall Inst. of Medical Research, Melbourne). J. Exp. Med., 128: 821-37 (Oct. 1, 1968).

The number of discrete hemolytic foci and of hemolysin-forming cells arising in the spleens of heavily irradiated mice given sheep erythrocytes and either syngeneic thymus or bone marrow was not significantly greater than that detected in controls given antigen alone. Thoracic duct cells injected with sheep erythrocytes significantly increased the number of hemolytic foci and 10 million cells gave rise to over 1000 hemolysin-forming cells per spleen. A synergistic effect was observed when syngeneic thoracic duct cells were mixed with syngeneic marrow cells: the number of hemolysin-forming cells produced in this case was far greater than could be accounted for by summating the activities of either cell population given alone. The number of hemolytic foci produced by the mixed population was not however greater than that produced by an equivalent number of thoracic duct cells given without bone marrow. Thymus cells given together with syngeneic bone marrow enabled irradiated mice to produce hemolysin-forming cells but were much less effective than the same number of thoracic duct cells. Likewise syngeneic thymus cells were not as effective as thoracic duct cells in enabling thymectomized irradiated bone marrow-protected hosts to produce hemolysin-forming cells in response to sheep erythrocytes. Irradiated recipients of semiallogeneic thoracic duct cells produced hemolysin-forming cells of donor-type as shown by the use of anti-H2 sera. The identity of the hemolysin-forming cells in the spleens of irradiated mice receiving a mixed inoculum of semiallogeneic thoracic duct cells and syngeneic marrow was not determined because no synergistic effect was obtained in these recipients in contrast to the results in the syngeneic situation. Thymectomized irradiated mice protected with bone marrow for a period of two wk and injected with semi-

allogeneic thoracic duct cells together with sheep erythrocytes did however produce a far greater number of hemolysin-forming cells than irradiated mice receiving the same number of thoracic duct cells without bone marrow. Anti-H2 sera revealed that the antibody-forming cells arising in the spleens of these thymectomized irradiated hosts were derived, not from the injected thoracic duct cells, but from bone marrow. It was concluded that thoracic duct lymph contained a mixture of cell types: some are hemolysin-forming cell precursors and others are antigen-reactive cells that can interact with antigen and initiate the differentiation of hemolysin-forming cell precursors to antibody-forming cells. Bone marrow contained only precursors of hemolysin-forming cells and thymus contained only antigen-reactive cells but in a proportion that was far less than in thoracic duct lymph. (auth)

6378 CELL TO CELL INTERACTION IN THE IMMUNE RESPONSE. III. CHROMOSOMAL MARKER ANALYSIS OF SINGLE ANTIBODY-FORMING CELLS IN RECONSTITUTED, IRRADIATED, OR THYMECTOMIZED MICE. Nossal, G. J. V.; Cunningham, A.; Mitchell, G. F.; Miller, J. F. A. P. (Walter and Eliza Hall Inst. of Medical Research, Melbourne). J. Exp. Med., 128: 839-53(Oct. 1, 1968).

Two new methods are described for making chromosomal spreads of single antibody-forming cells. The first depends on the controlled rupture of cells in small microdroplets through the use of a mild detergent and application of a mechanical stress on the cell. The second is a microadaptation of the conventional Ford technique. Both methods have a success rate of over 50%, though the quality of chromosomal spreads obtained is generally not as good as with conventional methods. These techniques were applied to an analysis of cell to cell interaction in adoptive immune responses, using the full syngeneic transfer system provided by the use of CBA and CBA/T6T6 donor-recipient combinations. When neonatally thymectomized mice were restored to adequate immune responsiveness to sheep erythrocytes by injections of either thymus cells or thoracic duct lymphocytes, it was shown that all the actual dividing antibody-forming cells were not of donor but of host origin. When lethally irradiated mice were injected with chromosomally marked but syngeneic mixtures of thymus and bone marrow cells, a rather feeble adoptive immune response ensued; all the antibody-forming cells identified were of bone marrow origin. When mixtures of bone marrow cells and thoracic duct lymphocytes were used, immune restoration was much more effective, and over three-quarters of the antibody-forming mitotic figures carried the bone marrow donor chromosomal marker. The results were consistent with earlier conclusions, namely that thymus contains some, but a small number only of antigen-reactive cells (ARC), bone marrow contains antibody-forming cell precursors (AFCP) but no ARC, and thoracic duct lymph contains both ARC and AFCP with a probable predominance of the former. A vigorous immune response to sheep erythrocytes probably requires a collaboration between the two cell lineages, involving proliferation first of the ARC and then of the AFCP. The results stressed that the use of pure thoracic duct lymphocytes in adoptive transfer work could lead to good adoptive immune responses, but that such results should not be construed as evidence against cell collaboration hypotheses. Some possible further uses of single cell chromosome techniques were briefly discussed. (auth)

6379 CELL TO CELL INTERACTION IN THE IMMUNE RESPONSE. IV. SITE OF ACTION OF ANTILYMPHOCYTE GLOBULIN. Martin, W. T.; Miller, J. F. A. P. (Walter and Eliza Hall Inst. of Medical Research, Melbourne). J. Exp. Med., 128: 855-74(Oct. 1, 1968).

It was shown that the immune response of mice to sheep erythrocytes requires the participation of two classes of lymphoid cells. Thymus-derived cells initially react with antigen and then interact with another class of cells, the antibody-forming cell precursors, to cause their differentiation to antibody-forming cells. Antilymphocyte globulin depressed the ability of mice to respond to sheep erythrocytes. This effect was more marked when the antigen was injected intraperitoneally than intravenously, and occurred only when the antilymphocyte globulin was given before or simultaneously with antigen. Injection of thymus cells restored to near normal the ability to respond to an intravenous injection of sheep erythrocytes. Spleen cells from antilymphocyte globulin-treated mice gave a weak adoptive immune response in irradiated recipients. The addition of thymus cells however enabled a response similar to that given by normal spleen cells. When thymectomized irradiated recipients were used, normal spleen cells continued to give a higher response to a challenge of sheep erythrocytes at two and four weeks postirradiation than did spleen cells from ALG-treated donors. This result is more consistent with the notion that thymus-derived target cells are eliminated, rather than temporarily inactivated, by antilymphocyte globulin. These findings suggest that, in vivo, antilymphocyte globulin acts selectively on the thymus-derived antigen-reactive cells. (auth)

6380 LEUKOCYTE LABELING WITH ^{51}Cr. I. TECHNIQUE AND RESULTS IN NORMAL SUBJECTS. McMillan, Robert; Scott, James L. (Veterans Administration Center, Los Angeles. Univ. of California, Los Angeles). Blood, 32: 738-54(Nov. 1968).

A method for labeling concentrated leukocytes in vitro with ^{51}Cr is described. Intravascular survival data and organ distribution of the ^{51}Cr-labeled leukocytes of ten hematologically normal subjects are presented and compared with the results of sequential or simultaneous granulocyte survival determinations using radioactive diisopropylfluorophosphate (^{32}DFP). Both granulocytes and lymphocytes were labeled by ^{51}Cr. No evidence of diminished cell viability or significant elution or reutilization of the label was demonstrated by in vitro studies. Curves of both ^{51}Cr and ^{32}DFP leukocyte radioactivity in the circulation were exponential, with average T ½ values of 10.5 and 10.3 hrs respectively, reflecting the random departure of labeled granulocytes from the circulation. An early rapid phase of label disappearance was noted in the ^{51}Cr studies, attributable to label elution or the disappearance of labeled nongranulocytic leukocytes. Body counting rate curves during the first 12 hrs paralleled the disappearance of leukocyte and plasma radioactivity; a later plateau reflected radioactivity in RBC contaminating the concentrated leukocyte suspensions. No evidence of pulmonary or splenic sequestration was noted. Estimations of granulocytic pool sizes from the ^{51}Cr data compared poorly with data derived using ^{32}DFP, probably as a result of the early elution of a portion of the radiochromate from the labeled cells or from the more rapid disappearance of ^{51}Cr-labeled mononuclear cells. Epinephrine infusion after injection of labeled leukocytes produced peripheral leukocytosis, increased counting rates over the lungs, liver, and heart and a marked diminution in counting rates over the spleen suggesting that a significant portion of the marginal granulocytic pool is located in the spleen. It was concluded that the ^{51}Cr labeling technique was useful in the study of the intravascular survival and tissue distribution of cells not labeled with ^{32}DFP, and that its use will supplement the study of granulocytes labeled with ^{32}DFP. (auth)

6381 TRANSPORT OF TWO NONMETABOLIZED NUCLEOSIDES, DEOXYCYTIDINE AND CYTOSINE ARABINOSIDE, IN A SUB-LINE OF THE L1210 MURINE LEUKEMIA. Kessel, David; Shurin, Susan B. (Children's Cancer Research Foundation, Boston. Harvard Medical School, Boston). Biochim. Biophys. Acta, 163: 179-87(Sept. 17, 1968).

Transport of cytosine arabinoside and deoxycytidine was examined in a subline of the L1210 murine leukemia unable to metabolize either nucleoside. At 37°, uptake of these nucleosides was unaffected by metabolic inhibitors, but apparently saturable. A cell medium distribution ratio of one was achieved, within one min of incubation, except at the highest nucleoside level tested (25 mM). Kinetic studies were mainly carried out at 0°, at which temperature nucleoside uptake was slowed and both saturability and structural specificity of nucleoside transport could readily be demonstrated. Nucleoside exit was non-linear at both 0 and 37°, i.e., a rapid phase of loss was followed by a much slower phase. The fast phase was inhibited by UO_2^{++} at either temperature. At 0°, the rapid phase exit of cytosine arabinoside or deoxycytidine could be inhibited by high intracellular levels of certain other nucleosides indicating that a process with structural specificity and saturability was involved. (auth)

6382 POSITIVE INOTROPIC ACTIVITY OF QUERCETIN AND ITS EFFECT ON RADIOCALCIUM MOVEMENTS. Carpenedo, F.; Ferrari, M.; Santi, R. (Univ., Padua). Acta Isotop., 7: 271-9 (Dec. 30, 1967).

Quercetin increased the release of ^{45}Ca from guinea pig left atria preincubated in presence of ^{45}Ca and electrically driven in solutions free of calcium or containing a low calcium concentration. The drug was not effective on staircase phenomenon. A possible relationship between the effects of quercetin on ^{45}Ca movements and the positive inotropic activity of this drug was suggested. Concerning the intimate mechanism underlying the effects of quercetin on ^{45}Ca movements, the importance of the chelating activity of this flavonoid was stressed. (auth)

6383 X-RAY-INDUCED PHYSICO-CHEMICAL ALTERATIONS IN DNA MACROMOLECULES. Furnica, M. Fiziol. Norm. Patol. (Bucharest), 13: 345-52(1967). (In Rumanian).

The main physicochemical changes occurring in DNA macromolecules after x-ray exposure, in vitro and in vivo are described. Irradiation in vitro of DNA aqueous solutions induced hydrogen bond-breaking and internucleotide splitting as well as alteration of the bases (the formation of hydroperoxides, glycols, formamidopyrimidines, hydroxylation of the methylene groups, deamination, and destruction of purines and pyrimidines). After irradiation in vivo, the DNA extract showed a decrease in the degree of polymerization, a quantitative reduction of the highly polymerized fraction, increased solubility in diluted saline solutions, lability

of protein bonds, a lower ^{32}P and ^{3}H-thymidine uptake in the highly polymerized fraction, and increased resistance to heat. (Rom. Sci. Abstr.)

6384 IDENTIFICATION AND ESTIMATION OF TRITIUM-LABELED RESERPINE IN BIOLOGICAL MATERIAL BY A COMBINATION OF THIN-LAYER CHROMATOGRAPHY AND LIQUID-SCINTILLATION RADIOASSAY. Manara, L. (Istituto di Ricerche Farmacologiche Mario Negri, Milan). Eur. J. Pharmacol., 2: 136-8(1967).

A method to measure low levels of reserpine in tissues is described. A high sensitivity is obtained by the use of ^{3}H-reserpine while high specificity is achieved through a combination of thin-layer chromatography and liquid scintillation radioassay. (auth)

6385 PEPSINOGEN IN RAT GASTRIC MUCOSA AFTER TOTAL GAMMA IRRADIATION. Schauer, Primoz (Inst. Microbiology , Ljubljana, Yugoslavia). Biol. Vestn., 14: 17-20(1966). (In Slovak).

Peptic activity was measured in homogenates of rat gastric mucosa 1, 24, 48, and 72 hr after whole-body ^{60}Co γ irradiation with 750 R. Peptic activities were increased in the first hr after irradiation, with a maximum specific activity at 48 hr and a maximum of total activity at 24 hr after irradiation. On the third day after irradiation, the peptic activity was still above the control value. (auth)

6386 EFFECT OF GAMMA RAYS ON THE PROTEOLYTIC ACTIVITY OF "IN VITRO" IRRADIATED BLOOD CELLS. II. EFFECT ON LYMPHOCYTE CELLS. Kopitar, Majda; Cotic, Vladimir; Turk, Vito; Lebez, Drago (Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia). Strahlentherapie, 136: 496-9(Oct. 1968).

Peripheral lymphocytes isolated by Garvin's method, modified by Rabinowitz, were irradiated in vitro at 37°C in suspension of 50% rabbit serum in Hank's buffer (pH 7.4). A correction for contribution of protein nitrogen by erythrocytes was introduced. Nitrogen values for erythrocytes and lymphocytes supernatant of 300,000 g min for 10^7 cells were determined. Supernatant nitrogen of 10^7 lymphocytes was determined by mathematical (25 γ of N for 10^7 lymphocytes) and experimental (60 γ of N for 10^7 lymphocytes) procedures. Proteolytic activity of pure lymphocytes (control and irradiated) was determined. The effect of dose range from 200 to 1200 R γ irradiation on lymphocytes cathepsins was studied 90 minutes after irradiation. A significant increase of catheptic activity was demonstrated with doses of 600 and 1200 R. (auth)

6387 FATE OF INTRAVENOUSLY INJECTED COPPER, CHROMIUM, LANTHANUM, MANGANESE, STRONTIUM, AND ZINC β-GLYCEROPHOSPHATES. Anghileri, Leopoldo J. (Institut fuer Nuklearmedizin, Heidelberg). Acta Isotop., 7: 281-8(Dec. 30, 1967).

The distribution of ^{51}Cr-, ^{64}Cu-, ^{56}Mn-, ^{140}La-, ^{65}Zn- and ^{85}Sr-labeled β-glycerophosphates was studied after intravenous injection into rats. All the β-glycerophosphates were excreted mainly through the urine. This behavior was related to their higher stability to the hydrolytic processes due to the coordinating tendency of β-glycerophosphoric acid. (auth)

6388 FORMATION OF SILK PROTEINS BY THE SILKWORM, BOMBYX MORI, AFTER GAMMA-RAY IRRADIATION IN THE EMBRYONIC STAGE. Shigematsu, H.; Takeshita, H. (Sericulture Experiment Station, Tokyo). J. Insect Physiol., 14: 1013-24(July 1968).

Silkworm eggs were γ irradiated (^{60}Co) to a dose of 8000 RAD in a late stage of embryonic development. Some biological and biochemical parameters were measured to study metabolic disturbances caused by irradiation, particularly those affecting silk formation. After irradiation, there was no difference in hatchability of eggs, but mortality of larvae increased, the larval period was prolonged, and the rate of growth of the body and silk glands was reduced. In irradiated larvae, the posterior division of the silk gland was hypoplastic but the middle division was not. Increase in weight of the posterior division of the silk gland almost ceased after the middle of the fifth instar in irradiated larvae. The rate of formation of silk proteins was less throughout the whole period from the 3rd to the 11th day of the fifth instar in the irradiated larvaa. The formation of fibroin was conspicuously affected. Synthesis of silk proteins, especially fibroin, was much reduced in the treated larva during the spinning period. Fibroin-synthesizing activity and content of nucleic acids in the posterior division of the silk glands of irradiated larvae were decreased. Incorporation of ^{14}C-glycine into protein in an in vitro system consisting of ribosomes and messenger RNA obtained from the posterior division of the silk glands indicated that irradiated larvae had lower activity of messenger RNA and accelerated activity of ribosomes. (BBB)

6389 PERICARDIAL ABSORPTION OF THORIUM DIOXIDE IN RATS. 3. ANALYSIS OF THORACIC DUCT LYMPH. Kluge, Trond. Acta Pathol. Microbiol. Scand., 72: 244-50(1968).

Thorotrast was injected into the pericardial cavity of rats, the thoracic duct was drained, and the radioactivity of the collected lymph was measured. Samples collected at different time intervals were assayed in a well scintillation counter. Radioactivity of ThO_2 was present in lymph samples as early as one hr following pericardial injection and reached a maximum between two and 12 hr later. The presence of radioactivity in all lymph samples showed that lymph was drained from the pericardium through the thoracic duct. The absence of radioactivity in the blood did not exclude the possibility of other lympho-venous communications. Blood from the tail vein had passed through the reticulo-endothelial system, where most Thorotrast particles were retained. Electron microscopy had shown that most of the injected ThO_2 was absorbed through the mesothelium during the first hour. By lymphography, however, visualization of lymphatics was delayed until the second hr. This difference between results obtained by lymphography and radioactive assay was probably due to the greater sensitivity of the latter method. (BBB)

6390 ACCELERATION OF ASCITES TUMOR GROWTH RATE BY SERIAL TRANSPLANTATION. Maruyama, Y.; Knuth, P. (Univ. of Minnesota Hospitals, Minneapolis). Growth, 30: 453-61(Dec. 1966).

The tumor studied was the LSA ascites lymphoma of C57BL/Ka mice that was x-radioinduced and of thymic origin. Its genesis involved a murine leukemic virus (radiation leukemia virus). Certain altered growth properties of the serially transplanted isologous tumor are reported. Ascites tumor growth curves were obtained by inoculating 2×10^7 cells intraperitoneally. The tumor exhibited an intraperitoneal growth curve characterized by an early exponential growth phase with a later stationary phase. A cell doubling time of 19 hr during the logarithmic growth phase was found. The effect of admixed heavily irradiated cells (in vitro doses of 5000 RAD) is shown. No clear acceleration of the type described earlier for Ehrlich ascites tumor was observable. Early counts were somewhat higher, consistent with a higher initial dosage, and a mixed population of viable and nonviable cells; the latter undergoing dissolution. The mean survival time data are shown in relation to data obtained during early passage, where the central tendency was determined by the geometric mean. Cell generation time, estimated indirectly by the survival time method, was 17 hr, corresponding closely with that obtained by direct cell count during logarithmic growth. The results indicated that marked changes in the tumor occurred after several years of serial transplantation. With large inocula, no change in response times occurred. With small inocula, less skewing relative to early experiments was observed. (BBB)

6391 A NEW TECHNIQUE FOR PLACEMENT OF RADIOACTIVE SOLUTIONS IN ROOT STUDIES AND A STUDY OF ROOT GROWTH OF PASPALUM COMMERSONII. Evans, T. R. (Commonwealth Scientific and Industrial Research Organization, St. Lucia, Queensland). Aust. J. Exp. Agr. Anim. Husb., 7: 447-52 (Oct. 1967).

A new technique is described for placement of radioactive solutions for studies on root growth. This technique involves placement ring of polythene tubing at a predetermined depth with an access tube leading to the soil surface. Cylinders of 16 gauge galvanized iron and of different diameters are used for placement of polythene rings. Soil is excavated from outside the cylinder as it is forced to the required depth; the polythene is placed in position and soil back-filled over it as the cylinder is withdrawn, thus leaving an undisturbed core of soil of the same diameter as the cylinder to the depth of placement. Radioactive solution introduced through the access tube from an automatic burette is distributed evenly in the soil by percolation from the perforated polythene ring. Rate of root growth of single plants through the undisturbed soil can be determined from measurement of radioactivity in plant leaves at various intervals of time. The technique was tested using ^{32}P as tracer and Paspalum commersonii Lam. as the test species. Root growth both vertically and laterally was measured. The advantages of this technique compared with others in use at present are discussed. (auth)

6392 FLUORESCENCE MICROSCOPY STUDY OF RADIATION DAMAGES IN LYMPHOCYTE NUCLEI. Manteifel, V. M.; Meisel, M. N.; Kir'yanova, E. A. (Inst. of Molecular Biology, Moscow). Izv. Akad. Nauk SSSR, Ser. Biol., No. 2, 192-203(Mar.-Apr. 1968). (In Russian).

Reaction of lymphocytes from white rat lymph nodes to ionizing radiation was investigated by combined methods of fluorescence and phase-contrast microscopy. Different types of nuclear damages were associated with variations of brightness and color of

fluorescence in the complexes of acridine orange with a damaged DNA-proteids. Two different forms of pycnosis denoted as bright and dark pycnosis were distinguished. The sequence of nucleus damages from the bright to the dark and to non-fluorescent pycnotic nucleus was seen. In the phase contrast these changes correspond to gradual increase of nucleus density. The dynamics of development of different forms of radiation damages in lymphocyte nuclei during the initial six hrs following exposure (1000 RADs) and three hrs after exposure (from 100 to 5000 RADs) was studied. The data were compared with the disturbances in the ultrastructure of lymphocyte nucleus organization. (auth)

6393 IMMUNOLOGICAL STUDIES ON THE MOUSE LEUKEMIA INDUCED BY VIRUS AND X-RAY IRRADIATION. Rokutanda, Maroto (Kyoto Univ.). Annu. Rep. Inst. Virus Res., Kyoto Univ., 10: 1-14(1967).

SC-1 and SX cells (cultured leukemia cells induced in S mice by virus and x irradiation, respectively) were antigenic in isologous (syngeneic) mice, because S mice showed transplantation immunity against these cells after previous immunization. Spleen cells from immunized mice were effective in suppressing the growth of SC-1 and SX cells in vivo and in vitro, whereas peritoneal cells were not. The sera from immunized mice were cytotoxic against SC-1 and SX cells. Intense immunological cross reactions, between SC-1 and SX cells were shown by every method employed in the experiments. This suggests that the occurrence of leukemia after irradiation may be attributable to latent viruses activated by x rays. Cytotoxic activity of the antisera was decreased by absorption with purified viruses. The sera of rabbits immunized by purified viruses were strongly cytotoxic against SC-1 and SX cells, and this toxicity was not eliminated by absorption with an extract of normal S tissue. It was concluded that cellular antigens of leukemia cells are closely related to constituents of the mature viron. Major target sites of cytotoxic antibody and growth-inhibitory, immunologically competent cells may be those where virus maturation takes place on the surface of leukemia cells. (BBB)

6394 EFFECT OF IONIZING IRRADIATION ON THE OXIDATION OF PALMITATE-1-^{14}C BY THYMUS AND LIVER. Miras, Constantinos J.; Mantzos, John D.; Legakis, Nicholas J.; Levis, Gabriel M. (Univ. of Athens). Contract AT(30-1)-3709. Radiat. Res., 36: 208-16(1968).

New Zealand rabbits, fasted for 12 hrs, were subjected to 500 RADs of whole-body ^{60}Co γ irradiation. K^+-palmitate-1-^{14}C oxidation was assayed with the 600 × g supernatant of thymus and liver homogenates, in the presence of ATP, at various time intervals from irradiation. For a period of 24 hrs following irradiation, oxidation by liver preparations was not significantly affected. The rate of oxidation by thymus was decreased to less than one-third of the control value within 12 hrs from irradiation and, at 24 hrs, was almost completely abolished. Increased ATP concentration could increase only to a small extent the oxidation by thymus preparations of irradiated animals. Oxidation by isolated thymus mitochondria was also inhibited by irradiation. Counting of the water-soluble oxidation products of palmitate-1-^{14}C suggests that the inhibition is not due to the impairment of the reactions of the citric acid cycle. The nonesterified fatty acid concentration of thymus was not altered at 12 hrs following irradiation. Esterification of K^+-palmitate-1-^{14}C into the thymus lipids was not affected 12 hrs after irradiation. (auth)

6395 RESPONSE OF TOBACCO AND HAPLOPAPPUS CELLS TO ULTRAVIOLET IRRADIATION AFTER POSTTREATMENT WITH PHOTOREACTIVATING LIGHT. Trosko, J. E.; Mansour, V. H. (Michigan State Univ., East Lansing). Contract AT(11-1)-1704. Radiat. Res., 36: 333-43(1968).

Experiments were performed to test whether significant amounts of pyrimidine dimers were produced in cultured cells of tobacco (Nicotiana tabacum L. var. Xanthi) and of Haplopappus gracilis by uv light in the biological dose range and whether either or both dark and light repair systems exist in these cells. Thymine-containing dimers were found to be formed quite readily in both kinds of cells, but neither kind appeared to possess the excision repair system. Results indicated that uv-radioinduced growth inhibition of tobacco cells could be photoreactivated and that tobacco cells could monomerize uv-induced, thymine-containing dimers in the DNA. On the other hand, neither increase in growth nor monomerization of dimers was observed in the uv-irradiated Haplopappus cell culture after treatment with photoreactivating light. (auth)

6396 IMMUNOLOGICAL CROSS REACTION BETWEEN MOUSE LEUKEMIA VIRUSES INDUCED BY THE INOCULATION OF CELL-FREE FILTRATE AND BY THE X-RAY IRRADIATION. Rokutanda, Makoto (Kyoto Univ., Japan). Annu. Rep. Inst. Virus Res., Kyoto Univ., 9: 105-16(1966).

Virus particles obtained from x-ray-induced (SX) leukemia and virus-induced (SC-1) leukemia were purified by density gradient centrifugation. They had a buoyant density of 1.16 to 1.18 g/ml in potassium tartrate solution. Distribution of ^{32}P radioactivity in the virus particles examined by the method of Schmidt–Thanhauser showed that 73% of radioactivity was in lipid fraction, 25% in RNA fraction, 2% in DNA fraction, and 1% in residual fraction. DNAase treatment before density gradient centrifugation reduced the content of DNA but RNAase treatment did not affect RNA content. This suggested that small amounts of DNA contained in the preparation might represent contamination. Cross reaction between SC-1 virus and SX virus was observed by use of the fluorescent antibody technique with anti-purified virus rabbit serum. Cross reaction of transplantation immunity between SC-1 cells and SX cells was also observed. It is suggested that there are common antigenic structures in tumor antigen(s) in leukemias induced by different methods (x irradiation or by viruses). (BBB)

6397 UNSCHEDULED INCORPORATION OF THYMIDINE IN ULTRAVIOLET-IRRADIATED HUMAN LYMPHOCYTES. Evans, Richard G.; Norman, Amos (Sloan-Kettering Cancer Inst., New York. Univ. of California, Los Angeles). Radiat. Res., 36: 287-98(1968).

The nature, degree, and kinetics of unscheduled thymidine incorporation previously shown to occur in 90% of irradiated lymphocytes was studied. The incorporation was severely depressed in the presence of 10^{-4} M acriflavine and by low temperature, but was unaffected by 10^{-3} M hydroxyurea or caffeine. Over a dose of 25 to 400 ergs/mm^2, the uptake of thymidine was increased by a factor of only 1.6, although the survival of lymphocytes, measured 5 days after irradiation, decreased by almost two orders of magnitude. (The survival curve suggests that 90% of the lymphocytes have a D_0 of 35 ergs/mm^2 and 10% have a D_0 of 250 ergs/mm^2.) After exposure to 25 ergs/mm^2, over 70% of the cells survived for 5 days in culture; moreover, cells which had been stimulated by this dose to incorporate thymidine transformed and divided after exposure to phytohemaglutinin. The final uptake of thymidine was significantly greater when a total dose of 75 ergs/mm^2 was fractionated into three doses of 25 ergs/mm^2 given at six hourly intervals than when it was given as a single dose. The degree of thymidine incorporation and the fraction of leukemia cells labeled were not significantly different from those in normal lymphocytes. (auth)

6398 DETERMINATION OF RADIOACTIVE IODINE IN PLANTS. Benes, Jaroslav; Mastalka, Antonin (Inst. of Nuclear Research, Prague). Jad. Energ., 14: 390-3(1968). (In Czech).

Descriptions are given of a radiochemical method for determining radioactive iodine in plants by capturing elementary iodine from the gaseous media into the carrier column with tetrachloromethane. Factors influencing the yield, separation of iodine from solutions, and capture into tetrachloromethane were evaluated. (R.V.J.)

6399 IODINE IN MITOCHONDRIA AND NUCLEI. Dillon, Richard S. (Bryn Mawr Hospital, Pa.); Hoch, Frederic L. Biochem. Med., 1: 219-29(Dec. 1967).

The total iodine content of liver mitochondria of hypothyroid rats was about 20% of that in mitochondria from normal rats. Injection of the hypothyroid rats with 5.2 mμg of L-thyroxine (T_4)/g and killing them two min later produced a liver mitochondrial iodine content 56% of normal. The iodine increment had a half-life of 10 min as measured by the iodine content of mitochondria from animals killed in 30 and 180 min. Skeletal muscle mitochondria and liver nuclei from hypothyroid rats contained 65% and 50% as much iodine, respectively, as those from normal rats, and injecting the animals with 5.2 mμg of L-T_4/g up to three hr before sacrifice produced no significant changes, although the iodine in muscle mitochondria rose slightly. The number of nucleoli per liver nucleus in untreated hypothyroid animals was 65% of that in normal nuclei, and was not changed by thyroxine treatment over the three-hr period studied. These results are consistent with those reported previously on functional changes in liver mitochondria from hypothyroid rats killed three hr after L-T_4 administration in vivo, well before the hormone affects nuclear RNA metabolism. About 75% of the iodine in normal liver mitochondria was butanol-extractable or -insoluble, and so represented thyroid hormone; injection of 5.2 μg of L-T_4/g two min before sacrifice raised the total iodine, butanol-extractable iodine, and butanol-insoluble iodine 20-fold. (BBB)

6400 A COMPARISON OF THE EFFECTS OF X-RADIATION ON THE RELATIVE RATES OF INCORPORATION OF LABELLED THYMIDINE AND CYTIDINE INTO MITOCHONDRIAL AND NUCLEAR DNA OF MORRIS HEPATOMAS. Chang, Lillie O. (Univ. of Virginia, Charlottesville); Looney, William B.; Morris, Harold P. Int. J. Radiat. Biol., 14: 75-8(1968).

The results of the preliminary studies on the depression of thymidine-5-^{3}H incorporation into mitochondria and nuclei of normal and regenerating liver suggested that the rate of incorporation into mitochondrial DNA was less affected by x irradiation than was the rate of incorporation into nuclear DNA. Initial studies on the relative rates of labeled thymidine and cytidine incorporation into the mitochondrial and nuclear DNA showed marked differences in the relative rates of incorporation of these two labeled precursors of DNA in the two organelles. Results are reported from studies on the relative rates of labeled thymidine and cytidine incorporation into the mitochondrial and nuclear DNA of four different transplanted mouse hepatomas with different growth, morphological, genetic, and biochemical characteristics, and the effects of x irradiation on the relative rates of incorporation of the two precursors. (auth)

6401 CHARACTERIZATION OF THE ENZYMATIC BREAKDOWN OF DNA IN ESCHERICHIA COLI IN RESPONSE TO IONIZING RADIATION. Chapman, John Donald. University Park, Pa., Pennsylvania State Univ., 1967. 85p.

Thesis.

The breakdown of DNA in E. coli induced by ionizing radiation was characterized in an attempt to understand more clearly the enzymes responsible for this process. This breakdown was measured by the release of incorporated ^{14}C-thymine from the cold acid insoluble fraction. The initial rate of breakdown of DNA was measured in E. coli B, B/r, Bs-1, and B_1 in response to a similar radiation dose. The initial rate was found to be similar for these strains although the final amount of material released to the acid soluble fraction was significantly different. No correlation could be made between the radiation sensitivity and extent of breakdown of these strains. The extent of breakdown could be interpreted in terms of a model involving the synthesis of an inhibitor to the degradation process effective within 10 minutes of irradiation. The DNA of E. coli Bs-1 was determined to be double stranded throughout the degradative process. This characteristic cannot be reconciled with models for degradation based on the molecular action or actions of the known DNAases of E. coli. From the temperature dependence of the initial rate of breakdown of DNA in E. coli Bs-1 an activation energy of 17.2 kcal/mole between temperatures 20°C and 40°C was calculated. The maximum rate of breakdown of DNA appeared at 43°C. The temperature dependence of the extent of breakdown of DNA in E. coli 15T-L- is consistent with the existence of two processes induced by the radiation. These processes are the breakdown of DNA beginning immediately after exposure of the cells to the radiation and the synthesis of an inhibitor of the breakdown process. The dose-effect characterization of degradation in E. coli Bs-1 showed that both the initial rate of breakdown of DNA and the extent of breakdown increased linearly with dose up to 10 to 13 krads and then reached maximum values of 2.9 percent per minute and 90 percent respectively. The effect of infection of E. coli Bs-1 by T2 and T4 bacteriophage was studied and revealed that the process of attachment of the phage was effective in inhibiting the radiation-induced breakdown of host DNA. The manner in which this inhibition occurred was similar to that reported for inhibition of host RNA synthesis by phage attachment. These studies suggest that DNA degradation is mediated by an enzyme system which is present in cells as a normal constituent and works in very close association with the DNA-dependent RNA polymerase. As well, it is suggested that the percent of DNA degraded by a bacterial cell is governed by the rates of two processes induced by the radiation. The first process is the breakdown of DNA and the second process would be the synthesis of an inhibitor of this breakdown. (Diss. Abstr.)

6402 EFFECT OF X-RAYS ON THE ELECTROLYTE TRANSPORT IN EHRLICH–ASCITES TUMOR CELLS. II. IRRADIATION OF CELL SUSPENSION. Hasl, Guenther; Pauly, Helmut (Univ., Erlangen, Ger.). Biophysik, 5: 237-47(1968). (In German).

Potassium transport into Ehrlich ascites tumor cells x-irradiated in diluted suspension was about ten times more radiosensitive compared to the sensitivity of tightly packed cells. This increase in radiosensitivity was caused by radiation products generated in the medium. The effect depended on the volume concentration of the cells in suspension and on the initial potassium content of the cells. The dose effect curve exhibited a threshold of about 10 to 20 Krad. After a dose of 20 Krad in a cell suspension of one volume per cent the potassium influx was significantly reduced. After a dose of more than 70 Krad the cells lost the ability to concentrate potassium. The transport mechanism showed a degree of recovery. The irradiation product H_2O_2 did not affect the reduction of the potassium concentration in cells irradiated in suspensions. (auth)

Ecology

Refer also to abstracts 6354 and 6433.

6403 (AEC-tr-6945) PRELIMINARY INVESTIGATIONS OF THE POSSIBLE INFLUENCE OF RADIATION ON THE NATURAL VEGETATION OF URANIFEROUS DEPOSITS OF THE CUYO REGION. Leal, A. R.; Roig, F. A. Translated from Rev. Fac. Cienc. Agr., Min. Educ., Univ. Nac. Cuyo (Mendoza), 12: No. 2, 99-149(1965). 57p. Dep. CFSTI.

In an attempt to discover possible influences of radioactivity on vegetation, a preliminary study was made of plants growing on the uraniferous parcels of Agus Botada in the Department of Malalhue; Los Chanares, in the Department of San Rafael; Mina Soberania in the Department of Las Heras of the Provincia de Mendoza, as well as the parcels of Cuesta de Huaco, Los Oscuros, Los Barreales, and Las Aguaditas of the Provincia de San Juan, Argentina. A careful examination was made of any aspect departing from the normal in each of the plant species studied. In principle, this was done on points of a previously used radiometric reticulate in the first two parcels. Later, radioactivity was measured only for the place the plants showed the anomalies, since this method was considered more expeditious. The anomalies found were documented through samples of herbarium, sketches, and photographs, and the observations were completed with general collections, both inside and outside of the parcels studied, for comparison and other purposes. This was done at the same time the vegetation was studied. In the first parcel, the research undertaken established the existence of six anomalies affecting five species; in the second parcel, twenty, affecting sixteen species; in the third, eight, affecting twelve species; in the fourth parcel, three anomalies affecting one species; in the fifth, three anomalies for two species; and in the sixth and seventh, three anomalies affecting one species were found. From the parallel investigation of nonradioactive zones it was concluded that a concentration of anomalies exists in radioactive soils. This was most pronounced for the region of Cuyo. In this regard, this parcel was the more interesting because of the accumulation of anomalies found and the greater number of species found. Distribution of the phenomena inside the parcels showed that the anomalies observed were not found at the points of highest radioactivity, but on the periphery where the values fluctuated, in general, between 0.014 and 0.022 mr/hr. At the points of highest radioactive values, there was sparse vegetation (the general case for all parcels) or vegetation simply did not exist. There were also bare zones (rocky outcroppings) that indicated the vegetation only recently found conditions to its liking. When plants were found near points of high radioactivity values, or on these points, they showed the withering of weak or dying organisms, and no traces that normal sexual reproduction had taken place. Many of the anomalies found are numbered among those described in teratology. Other anomalies that are not known are described and designated with new epithets that are proposed as a means of defining them. Data on the anomalies found in each species are tabulated. Most of the anomalies were absolutely analogous to those induced experimentally through exposure to ^{60}Co γ radiation. (auth) (TSS)

6404 (BNWL-714, pp 8.1-25) TERRESTRIAL ECOLOGY STUDIES. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

ANGIOSPERMIDAE—Sarcobatus vermiculatus, uptake of sodium and water by, from saline soils
—Hardeum vulgare, radioisotope uptake from soils by, americium-241 and plutonium-239
—Phaseolus sp., radioisotope uptake from soils by, americium-241 and plutonium-239
CESIUM-137—content of food chains and man in Alaska during 1967
—metabolism in darkling beetles
GAMMA RADIATION—effects on survival of wild mice, effects of dose on
ECOLOGY—desert region, effects of ground water content and water potential of plants and soil on (C.H.)

6405 (BNWL-714, pp 9.1-35) AQUATIC ECOLOGY. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

OSTEICHTHYES—Oncorhynchus tshawytscha, survival in Columbia River, effects of water temperature on
—Oncorhynchus sp., virulence of Chondrococcus columnaris in
MOLLUSCA—Fischerola nuttalli, zinc-65 uptake and retention by, in Columbia River
—Margaritifera margaritifera, incidence of amoebic infections and neoplasms in, in Columbia River
—Anodonta californiensis, incidence of neoplasms in, in Columbia River
CRUSTACEA—Anonyx sp., zinc-65 uptake by, in Columbia River
CHLOROPHYTA—zinc-65 uptake by, in Columbia River
ANGIOSPERMIDAE—Gomphonema parvulum, zinc-65 uptake and retention by, in Columbia River

INSECTA — Tricoptera sp., development in Columbia River, effects of water temperature on (E.R.B.)

6406 TICKS OF THE NATIONAL REACTOR TESTING STATION. Allred, Dorald M. Brigham Young Univ. Sci. Bull., Biol. Ser., 10: No. 1, 1-29(June 1968). (COO-1559-1).

Physical characteristics of the area are described and photographs of study areas are presented. Descriptions and photographs of traps and collecting equipment are given. The scientific names of the vertebrates collected are listed together with dates and localities of collections. During the period from June, 1966, to September, 1967, 27 amphibians of two species, 446 reptiles of eight species, 561 birds of 81 species, and 4050 mammals of 26 species were examined for ectoparasites. Of seven species of ticks collected, the predominant one was Ixodes kingi, found on mammals of 12 species. Next in abundance was Dermacentor andersoni found on birds of three species and mammals of 16 species. Haemaphysalis leporispalustris was taken from birds of ten species and six species of mammals. Four other species of Ixodes were taken from birds of four species and seven species of mammals. Where adequate samples were taken, the highest percentage of hosts infested with Dermacentor andersoni was 8% for birds and 29% for mammals. Haemaphysalis leporispalustris was found on as many as 53% of the birds and 29% of the mammals. Ixodes kingi infested as many as 46% of the mammals. Apparently there was little competition between ticks of different species relative to their simultaneous infestation of the same host. Highest populations of ticks were found in areas where both sagebrush and grass were predominant. In an area where radioactive wastes were buried, fewer ticks and infested mammals were found than in a non-irradiated control area of a similar habitat. The frequency index was lower for Dermacentor and Ixodes than at the non-irradiated control site and the tick-host index was much lower in the irradiated area than at the control site. (H.L.W.)

Genetics and Cytogenetics

Refer also to abstracts 6403, 6563, 6571, 6606, and 6613.

6407 (AECD-RB-8) MUTAGENIC EFFECT OF GAMMA RAYS ON THE IMMATURE AND MATURE SPERMS OF SILKWORM, BOMBYX MORI. Molla, S. A.; Hossain, M. M.; Mallik, M. U. (Atomic Energy Centre, Dacca (Pakistan)). Mar. 1968. 6p. Dep.

Immature and mature sperms of silkworms were irradiated at 1, 2, 3, and 4 Krads. Mutagenic action of the radiation γ was estimated by applying unfertilized egg production test and dominant lethality test. It was shown that the mature sperms were least responsive to radiation. (auth)

6408 (NYO-2902-12) MUTATIONS TO SEX-LINKED LETHALS IN THE MOUSE. [Progress Report], August 15, 1967-August 15, 1968. Caspari, Ernst W.; Eicher, Eva M. (Rochester Univ., N. Y.). Sept. 6, 1968. Contract AT(30-1)-2902. 19p. Dep. CFSTI.

Male mice of the genetic constitution Xfd/Y p/p were irradiated with 350 R x rays and mated to p/p females. In F_1 1/40 exceptional (p/p) females were obtained in the presterile period, and 1/41 in the poststerile period. This compares to 5/145 similar mutational events in the unirradiated controls. There is, from these data, no evidence for an increase in p/p females due to irradiation. In the irradiated sample, 1 exceptional (wild type) male was found. The F_1 obtained from irradiated Xfd/Y p/p males showed a highly significant distortion of the sex-ratio in favor of the males: 72 males: 40 females, i.e., 64% males. No deviation was found in the controls (47.7% males) and in the F_1 obtained in the poststerile period from the same males (46.8% males). Since, in addition, the litter size in the presterile period was depressed, compared to controls and to the poststerile period, it was assumed that radiation induced dominant lethals in the Xfd chromosome. This effect appeared to be promising for the study of radiation genetics, because the effect was strong, and could be scored at birth in F_1. (auth)

6409 (ORNL-tr-1959) INFLUENCE OF GENOTYPE ON INTERALLELIC COMPLEMENTATION AND SUPER-SUPPRESSION IN YEASTS. Soidla, T. R.; Inge-Vechtomov, S. G. Translated for Oak Ridge National Lab., Tenn., from Genetika, No. 9, 141-50(1966). 16p. Dep. CFSTI.

The influence of genotype on interallelic complementation was detected in the ad_2 locus in mutants of the yeast Saccharomyces cerevisiae induced by uv and x radiation. The existence of a modifier gene of super-suppression was demonstrated. The data obtained indicate that the super-suppression modifier is one of the genes that alter the character of interallelic complementation of the ad_2 locus. (auth)

6410 MORPHOLOGICAL CHARACTERISTICS AND CYTOGENETICS OF FIFTEEN TOBACCO MUTANTS. Saccardo, F.; Devreux, M. (CNEN, Rome). Caryologia, 20: 239-56(1967). (In Italian). (RT/BIO-(68)32).

Gametes, zygotes, and proembryos of Nicotiana tabacum purpurea were irradiated with ^{60}Co γ rays (exposures of 1, 2, and 4 kR) and 15 mutant lines, isolated from these treatments, are described. The majority of the mutants showed reduction in height, narrow leaves, and changes in several floral characters, namely: color, calix size, length and width of corolline tube, and length of stamens and pistils. The cytogenetic analysis revealed the presence in the apical meristems of several mutants (still in the sixth generation after irradiation) of double bridges, that can be explained with the transmission of dicentric chromosomes; multivalents were also found in the P.M.C. of some mutant lines, accompanied by a reduced pollen fertility. These structural abnormalities can evidently be tolerated because of the polyploidy of N. tabacum. (auth)

6411 MUTAGENESIS IN ESCHERICHIA COLI: EVIDENCE FOR THE MECHANISM OF BASE CHANGE MUTATION BY ULTRAVIOLET RADIATION IN A STRAIN DEFICIENT IN EXCISION-REPAIR. Bridges, B. A.; Munson, R. J. (Medical Research Council, Harwell, Eng.). Proc. Roy. Soc. (London), Ser. B, 171: 213-26(Nov. 5, 1968).

The mutagenic action of uv radiation was studied upon Escherichia coli WP2 try hct growing exponentially at 37°C. Although this strain is unable to excise pyrimidine dimers from its DNA it showed no detectable reduction in growth rate after exposure to a dose of uv (10^{-6} J mm^{-2}) calculated to produce several dozen pyrimidine dimers per chromosome. As judged by photoreversibility of mutations to prototrophy, dimers at mutable sites may persist for up to about 4 generation times after uv and may give rise to mutations with a low probability in each replication cycle during this period. The slow disappearance of dimers takes place whether or not DNA replication is inhibited, and indirect evidence suggests that excision-repair may not be involved. Mutations are established (i.e., become nonphotoreversible) only when DNA replication is taking place, and are not expressible on unsupplemented medium until approximately one generation time after being established. It is suggested that the mutation is initially produced by the laying down of an incorrect base opposite a pyrimidine dimer at, or shortly after, replication; the mutation becomes transcribable only after a further replication gives rise to a duplex mutant in both strands. The observed segregation pattern strongly suggests that at this further replication the mutation is carried by both resulting daughter duplexes. This implies that the mutant strand initially produced opposite the dimer has a strong influence on the bases of both new strands laid down at the next replication. (INIS) (UK)

6412 MUTATIONS IN E. COLI C AFFECTING LYSOGENIZATION BY THE TEMPERATE PHAGE P2. Sironi, G. (Karolinska Inst., Stockholm, Univ., Milan). Atti Ass. Genet. Ital., 13: 306-8(1968). (In Italian).

From Conference on Genetics, Naples, Italy. See CONF-671057-(Vol.13).

Mutants of Escherichia coli C (lyd = lysogenization defective) that were not lysogenized by phage P2 were obtained by treatment with uv or N-methyl-N′-nitro-N-nitrosoguanidine. The inability to lysogenize lyd strains appears to be specific for phage P2. Lyd mutants showed several new properties, as compared to the original strains: higher sensitivity to x rays of uv light, although they reactivate normally uv-irradiated T1: lower recombination frequencies in bacterial crosses: lower transduction frequencies in P1-mediated transduction. The lyd mutation maps in proximity of the xan marker on the E. coli C chromosome. Crosses between P2-lysogenic donors and lyd recipients showed that the lyd mutation was not a deletion of a chromosite, although lyd (P2) recombinants could not be recovered from such crosses. This seems to exclude that lack of lysogenization of lyd cells by P2 be due to lack of insertion. Spontaneous mutants (old = overcoming lysogenization defectivity) of P2 were isolated that were able to lysogenize lyd cells. These are homoimmune with P2. Moreover, the old gene appeared to be located on the P2 map far away from mutations known to affect immunity. These results seem to rule out the possibility that lyd cells are not lysogenized by P2 because of abnormal immunity. Mixed infection experiments with P2 and P2 old show that P2 old does not help P2 in lysogenizing lyd mutants. The old mutation shows another property: P2 prophage inhibits growth of superinfecting λ: P2 old mutants, in the prophage state, allow growth of λ. In a similar case, where prophage WΦ that is similar to P2, inhibits growth of superinfecting λ it was shown that λ DNA was degraded upon infection. The following model is proposed in order to explain the results described: the old^+ gene of P2 inhibits growth of λ in E. coli C (P2) and causes

inviability of the infected host cell unless the lyd$^+$ gene is present. This model is now being tested experimentally. (auth) (TSS)

6413 GENETICS EFFECTS OF CHRONIC GAMMA IRRADITION IN DURUM WHEAT. Donini, B. (CNEN, Rome). Atti Ass. Genet. Ital., 13: 269-71(1968). (In Italian).

From Conference on Genetics, Naples, Italy. See CONF-671057-(Vol.13).

Three cultivars of durum wheat, Cappelli, Aziziah, and Russello, and a radioinduced stable mutant of Cappelli, Brachytic, were subjected to chronic γ irradiation from ^{60}Co for their whole life cycle (from above leaf stage to harvest). Radiation exposures of 5, 10, 15, 20, 25, and 30 R/20 hr day were applied. Mature spikes were harvested from the irradiated plants keeping spikes produced by the main culms separate from those produced by tillers. Both spikelet fertility and germination of caryopses decreased with increasing exposure rate. In the first generation from irradiated plants, no case of chloropyll mutation was found. In the second generation, chlorophyll mutations were ascertained in two categories of plants: plants heterozygous for the mutation (all spikes segregating for the mutation) and plants chimeric for the mutation (segregation for mutants in one or two, but not all, spikes). The two types of mutations occurred with a frequency of 20 and 80%, respectively. This shows that, in durum wheat plants irradiated for their whole life cycle, the majority of recoverable mutations are induced in the post-fertilization diplophase: i.e., during development and maturation of the embryos. Seventy two out of 78 of the mutations occurring in chimeric plants of Cappelli and Aziziah were found in the progeny of the main spikes of irradiated plants. The possible reasons for this striking difference between main, and secondary, spikes in undergoing mutations during embryogenesis are discussed. A great variation in response to genetic effects of radiation among the four types of durum wheat tested was ascertained. It was ascribed to different characteristics of their life cycle rather than to differences in radiation sensitivity. (auth)

6414 VARIATIONS IN THE CORRELATIONS BETWEEN TWO INDUCED CHARACTERISTICS THROUGH SELECTION IN TRITICUM DURUM. Palenzona, L. D. (Univ., Bologna). Atti. Ass. Genet. Ital., 13: 254-62(1968). (In Italian).

From Conference on Genetics, Naples, Italy. See CONF-671057-(Vol.13).

Two populations of Triticum durum, one irradiated with 10,000 R of x rays, and another untreated (control), kept under controlled self-fertilization for three generations after the irradiation, underwent a stabilizing selection in the length of the first internode and a disruptive selection on the length of the second internode. Three characters were measured after four generations of selection, that is, the selected characters plus the height of the main stem. The results show that applied selection was able to change the mean values of three characters considered in the irradiated population, while being without such an effect on the control population. The variability was modified by the selection in different ways in the two populations considered: in the irradiated population the variance of the minus-selected plants was greater than that of the plus-selected; in the control population the opposite situation was found. The correlation was modified by the applied selection in the control population but remains unmodified in the irradiated population. The complexity of the results shown, suggests the existence of homeostatic mechanisms that oppose the modification of the correlation between characters, and that those mechanisms are more effective in the irradiated population probably because of the variability present in that population. (auth)

6415 ASSOCIAZIONE GENETICA ITALIANA ATTI DELLA XII RIUNIONE SCIENTIFICA, NAPOLI, 12-14 OTTOBRE 1967. VOL. XIII. (Italian Genetics Association from the 13th Scientific Reunion, Naples, October 12-14, 1967. Vol. XIII). Atti Ass. Genet. Ital., 13: 1-370(1968). (In Italian). (CONF-671057-(Vol. 13)).

A record of the proceedings of the 13th Scientific Reunion of the Italian Genetics Association in Naples during Oct. 1967, is presented. Included are 50 research papers on human genetics, animal genetics, plant genetics, genetics of microorganisms, and chemical genetics; a review of the genetic control of meiosis, and eight notes on subjects in various fields of research. Separate abstracts were prepared on four papers. (M.M.B.)

For abstracts of individual papers see: 6412–6414 and 6561.

6416 NUCLEAR DAMAGE AND THE AGEING OF SEEDS. Roberts, E. H.; Abdalla, F. H.; Owen, R. J. pp 65-100 of Aspects of the Biology of Ageing. Cambridge, Eng., Cambridge University Press, 1967.

The relation of ageing to chromosome aberrations and mutations in seeds of various plants is reviewed along with the effects of environmental factors on seed viability. Different methods for describing the relation among moisture content, temperature, and viability period are reviewed. The effects of oxygen and the rate of ageing in relation to the rate of accumulation of chromosome damage are considered. A number of possible explanations for chromosome damage in ageing seeds are explored. The effects of ionizing radiation and the role of DNA are discussed. Seed ageing and effects with bacteria and other organisms are considered and it is suggested that seeds provide good material for the study of problems of senescence. A mathematical model for seed survival curves is presented. (CO)

6417 GENE-CONTROLLED RADIATION SENSITIVITY IN YEAST. I. THE INFLUENCE OF THE UVS$_1$ MUTATION ON THE SENSITIVITY TO ULTRA-VIOLET LIGHT AND INDUCED MITOTIC RECOMBINATION. Zakharov, I. A.; Kozhina, T. N. (Ioffe Inst. of Physics and Tech., Leningrad). Genetika, 4: No. 9, 59-64(Sept. 1968). (In Russian).

An uv-radiosensitive mutant of the yeast Saccharomyces cerevisiae was isolated. The gene responsible for the radiation sensitivity was designated as uvs$_1$. In the haploid state of the uvs$_1$ mutation the sensitivity to the lethal effect of uv radiation was 20 times as high and that of the homozygous diploid uvs$_1$ uvs$_1$ was 25 times as high as the sensitivity of the wild-type haploid and diploid strains respectively. The mutant strains, haploid and diploid, had different survival curves; the curve of the haploid strain is exponential, while the diploid strain is characterized by a multihit type curve. The rates of the uv-induced mitotic recombination in the diploids uvs$_1$ uvs$_1$ ad$_1$ad$_1^+$ ad$_2$ad$_2^+$ and uvs$_1^+$ uvs$_1^+$ ad$_1$ad$_1^+$ad$_2$ad$_2^+$ were also studied. The uv-sensitive diploid had also a high sensitivity to the recombinogenic action of the uv radiation, but when the doses showing the same rate of survival were compared, it was seen that the diploid uvs$_1$uvs$_1$ gave fewer recombinants than the wild-type diploid. These experimental results suggest the participation of the uvs$_1$ gene in the process of the dark repair of the uv-induced primary lesions leading both to cell inactivation and to mitotic recombination. (auth)

6418 GENE-CONTROLLED RADIATION SENSITIVITY IN YEAST. II. THE UV-INDUCTION OF CYTOPLASMATIC MUTATIONS IN STRAINS WITH DIFFERENT RADIOSENSITIVITY. Kozhina, I. N.; Stepanova, V. P. (Ioffe Inst. of Physics and Tech., Leningrad). Genetika, 4: No. 9, 65-9(Sept. 1968). (In Russian).

The influence of uvs$_1$ mutation on the frequency of uv-induced respiration-deficient cytoplasmic mutations was investigated in the haploid and diploid strains of Saccharomyces cervisiae. The uv-sensitive strains were also highly sensitive to the mutagenic action of the uv light. At the uv-doses equal with respect to survival the wild-type, haploid and diploid strains showed a higher frequency of uv-induced cytoplasmic mutations than the uv-sensitive strains. Experimental results suggest that the reparation system is located both in the nucleus and in the cytoplasm. The genetic control of the synthesis or regulation of respiratory enzymes can be accomplished by cytoplasmic DNA containing structures. (auth)

6419 LETHAL AND MUTAGENIC EFFECT OF UV AND MITOMYCIN C ON THE MUTANTS OF ESCHERICHIA COLI WITH A REDUCED CAPACITY OF DARK REPARATION. Smirnov, G. B.; Skavronskaya, A. G. (Gamaleya Inst. of Epidemiology and Microbiology, Moscow). Genetika, 4: No. 9, 105-10(Sept. 1968). (In Russian).

The sensitivity of the wild-type bacteria and of the mutants devoid of the dark reparation system (DR-system) to the lethal and mutagenic action of uv and mitomycin C was studied. It was shown that the loss of the DR-system was accompanied by the loss of the ability to repair prelethal but not premutational lesions induced by mitomycin C. Only one mutant, dar$_7^-$, was characterized by an increased mutability caused by the influence of mitomycin C. On the basis of the degree of sensitivity of this mutant to the lethal effect of mitomycin C it was assumed that the increased mutability of the latter was the result of the loss of the capacity of repair rather than of a greater number of damages induced by the antibiotic. The data suggested that the premutational lesions induced by mitomycin C could be repaired, and this repairing effect was independent of the DR-activity, but could be lost in consequence of some mutations of special kind. (auth)

6420 REPARATION, BY THE HOST-CELLS, OF MUTATIONAL AND LETHAL LESIONS INDUCED BY UV-IRRADIATION OF AN EXTRACELLULAR BACTERIOPHAGE. Ktsoyan, Zh. A.; Val'dshtein, E. A.; Kriviskii, A. S. (Inst. of Experimental Biology, Erevan. Inst. of Cytology, Leningrad. Inst. of Molecular Biology, Moscow). Genetika, 4: No. 9, 117-127(Sept. 1968). (In Russian).

The lethal and mutagenic effects of uv irradiation on the extracellular temperate phage λ_{11} (a spontaneous mutant of the phage λ) were studied. The rate of survival of the irradiated phage λ_{11} after its replication in the cells of Escherichia coli K-12

hcr^{-1} was considerably lower than after the replication in the cells of E. coli K-12 hcr^{+}. The uv irradiation of the phage λ_{11} induces the initiation of vir-mutants that, unlike the wild type, were capable of self-reproduction in E. coli K-12 (λ). The initiation of vir-mutants was the result of the true mutagenic (not selective) effect of the uv light. The phage λ_{11} uv-irradiated at doses optimal for mutagenesis and replicated in E. coli K-12 hcr^{+} and in E. coli K-12 hcr^{-} exhibited 100-fold and 7000-fold increases of mutation rate over the spontaneous rate respectively. Thus, the host cell repairs in the phage not only lethal, but also premutational uv-damages, the latter to a lesser extent than the former. The uv-dose-effect relation for the vir-mutation is complex and does not fit any simple dependence, either one-hit or multi-hit. Similar results were obtained with the uv-irradiated c-mutant (clear) of the phage λ_{11}. (auth)

6421 EFFECTS OF SODIUM FLUORIDE AND IODOACETAMIDE ON MUTATION INDUCTION BY X-IRRADIATION IN MATURE SPERMATOZOA OF DROSOPHILA. Mukherjee, R. N.; Sobels, F. H. (Univ. of Leiden. Inst. for Radiopathology and Radiation Protection, Leiden). Mutat. Res., 6: 217-25(Sept.-Oct. 1968).

The effect of two inhibitors of glycolysis, NaF and iodoacetamide on the production of recessive lethal mutations by x rays in mature Drosophila sperm was investigated. Pre-treatment with NaF resulted in a consistent and highly significant increase of the mutation frequency. This effect was thought to result from interference with a repair process that made use of energy produced by glycolysis, and did not arise from an increase of the oxygen tension. When the action of NaF was studied in combination with pre- and post-treatments with N_2 and O_2, it was observed that: irrespective of pre-treatment with N_2 or O_2, NaF enhanced the mutation frequency over that in the saline controls; and following irradiation under anoxia, post-treatment with N_2 reduced the mutation frequency below that observed with O_2 post-treatment, even when the flies were pre-treated with NaF. These additive effects of NaF pre-treatment and O_2 post-treatment were taken as an indication that, even when glycolysis is inhibited by NaF, some energy is left, that is still available for repair by post-radiation anoxia. This interpretation that the amount of repair in sperm depends on different levels of available energy was supported by the observation that NaF pre-treatment was still effective in increasing the mutation frequency over that in the controls, when N_2 was given before, during, and after irradiation. Pre-treatment with iodoacetamide gave more variable results than that with NaF. (auth)

6422 DNA REPAIR AND INDUCTION OF MUTANTS WITH ALTERED DNA BASE COMPOSITION: STUDIES ON ESCHERICHIA COLI AND BACTERIUM PARACOLI. Gause, G. F.; Dudnik, Yu. V.; Netyksa, E. M.; Klizunova, N. V.; Kusovkova, L. I.; Selesneva, T. I. (Inst. of New Antibiotics, Moscow). Mutat. Res., 6: 211-15(Sept.-Oct. 1968).

The possibility of inducing mutants with altered DNA base composition by uv radiation was investigated in three strains of Escherichia coli in which trypaflavine inhibited repair of uv lesions, and in two strains of Bacterium paracoli in which repair was not susceptible to inhibition by trypaflavine. The extent of repair inhibition differed greatly in the three different strains of E. coli, but mutants with altered DNA base composition were never induced in any of these strains. In two strains of B. paracoli with the repair process insensitive to trypaflavine, mutants with altered DNA base composition were regularly induced by uv radiation. (auth)

6423 FINE STRUCTURE ANALYSIS OF A CHROMOSOME SEGMENT IN DROSOPHILA MELANOGASTER. ANALYSIS OF X-RAY-INDUCED LETHALS. Lifschytz, E.; Falk, Raphael (Hebrew Univ., Jerusalem). Mutat. Res., 6: 235-44(Sept.-Oct. 1968).

Allelism tests were performed between x-radioinduced lethals that were located on the X-chromosome of Drosophila at a region covered by the Y, $ma\text{-}l^{+}$ translocation. The complementation map that was constructed from the matrix of allelic combinations proved to be linear. So far 20 sections, or functional units, were delineated. Further analysis should increase the number of sections until each section comprises one cistron. Practically all post-meiotic x-radioinduced lethals in the region were aberrations. It was inferred that visible mutations induced by x rays were deficiencies at nonessential loci. The breakage points of mutations in the segment were not distributed at random. The hot spot was attributed to an intercalary heterochromatic band, that by pairing with the adjacent proximal heterochromatin caused preference in breaks simultaneously at the hot spot and the proximal heterochromatin, and hence also caused preference for extensive aberrations. A correlation was found between male sterility and heterochromatic aberrations, but not between male sterility and X:A translocations. This kind of analysis suggests new approaches to the study of the organization of the genetic material in chromosomes and the nature of various mutational events. (auth)

6424 EXCHANGE HYPOTHESIS AND CHROMOSOME-TYPE ABERRATIONS. Brewen, J. G.; Brock, R. D. (Oak Ridge National Lab., Tenn. CSIRO, Canberra, Australia). Mutat. Res., 6: 245-55(Sept.-Oct. 1968).

Regression analyses of the dose-response curves of radiation-induced chromosome aberrations in blood cells of Wallabia bicolor (2n = 11) showed that the kinetics of yield of terminal deletions, as well as classical two-lesion aberrations (rings, dicentrics, and intercalary deletions), best fit the model, $Y = a + cD^2$. In addition, all aberrations, including terminal deletions, responded to a fractionated dose in the way expected of two-hit aberrations. These observations suggest that terminal deletions originate from two-hit events. It is proposed that they result from incomplete exchanges, in accord with Revell's explanation of the origin of chromatid deletions, rather than from single breaks as proposed on the breakage first model. (auth)

6425 CHLOROPLAST ABERRATIONS IN IRRADIATED FERN SPORES. Howard, Alma; Haigh, Mary V. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Mutat. Res., 6: 263-80(Sept.-Oct. 1968).

Aberrations affecting chlorophyll and/or chloroplasts were scored among the survivors of irradiated haploid spores of the fern Osmunda regalis. They were classed in eight recognizable groups, that occurred in the same relative numbers in irradiated and control samples. Two distinct types, comprising respectively 4.7% and 1.6% of all the aberrations, gave evidence of being due to mutation of nuclear genes. All the aberrations exhibited a high degree of somatic stability. The frequency of occurrence of aberrations was closely correlated with the rate of cell killing in all experiments. Factors that modified the effectiveness of the radiation in killing spores always modified to a similar extent its effectiveness in producing aberrations among the survivors. These factors included LET of the radiation, the physiological state of the spores at the time of irradiation, whether the radiation dose was given at a single exposure or in two fractions, and the presence of oxygen during irradiation. In unirradiated spores the aberration rate increased markedly with length of time in storage. (auth)

6426 MODIFICATION OF RADIATION DAMAGE WITH STORAGE IN SEEDS IRRADIATED WITH THERMAL NEUTRONS. Rao, N. S.; Joshua, D. C.; Mistry, K. B.; Gopal-Ayengar, A. R. (Bhabha Atomic Research Center, Bombay). Mutat. Res., 6: 281-8(Sept.-Oct. 1968).

Irradiation of seeds with thermal neutrons induced radioactivity in seeds. A study was undertaken to find out how the storage of the radioactive seeds, and consequent decay of activity, modified the radiation damage. Immediate hydration after thermal neutron irradiation of rice seeds showed higher mutation frequency than that obtained after storage of the seeds for 10 days. The spectrum of chlorophyll mutations was also different. Chromosome aberrations were scored in barley seeds in which immediate hydration increased the frequency of chromosome fragments. The study of γ-ray spectra and β-activity in irradiated rice and barley seeds showed detectable activation of Mg, P, K, and Cu. Transmutation of elements and internal radioactivity were considered likely to contribute to the radiation damage. Even though the activity by itself was too small to cause direct damage, perhaps transmutation and internal activity were able to modify the initial radiation damage in diverse ways. Restitution or repair of the lesions may have been affected leading to the enhanced effects noted. (auth)

6427 INDUCTION OF MUTATIONS IN BROMOURACIL-CONTAINING SALMONELLA TYPHIMURIUM EXPOSED TO ULTRAVIOLET LIGHT. Skavronskaya, A. G.; Pokrovskii, V. N.; Likhoded, L. Ya. (Gamaleya Inst. for Epidemiology and Microbiology, Moscow). Mutat. Res., 6: 319-21(Sept.-Oct. 1968).

The effects of 5-bromouracil on uv-radioinduced reverse mutations to prototrophy in a leucine-requiring derivative of Salmonella typhimurium LT2 36 were studied. This mutant was induced by 5-bromouracil. Bacteria grown in media containing leucine, 5-bromouracil, and sulfanilamide and suitable control samples were irradiated. Survival of colony-forming ability and frequency of prototrophs were determined for various doses of uv radiation. The presence of 5-bromouracil enhanced both the lethal and mutagenic effects of the radiation. (M.M.B.)

6428 ON THE DIVERSE ABERRATION: MUTATION RATIO INDUCED BY NMU. Sharma, B. (IARI, New Delhi). Curr. Sci. (India), 37: 675-6(Dec. 5, 1968).

The frequency of mutations and chromosome aberrations induced in pea plants by N-nitrosomethyl urea (NMU) was compared with 2 to 4 kR γ radiation and 100 to 200 RADs fast neutrons. The mutagenic effect of NMU was greater than the two radiations. The frequency of chromosome aberrations, on the contrary, was lowest with NMU. Results suggested that both fast neutrons and NMU inhibited the joining of broken ends of the chromosomes. (C.H.)

6429 RADIOPROTECTION AND RADIOPATHOLOGY. Delpla, M. (SGR-EDF, Paris). Radioprotection, 3: 131-42 (1968). (In French).

The laws governing the somatic and genetic effects of radiation must be understood before adequate radiation protection standards can be devised. The contradictions in the evidence on the induction of cancer or leukemia by radiations are emphasized. Results of studies on the genetic effects of radiation on mice are summarized that show variations of the mutation rate with age and exposure dose, restoration capacity for the mutagenic effect, differences in radiosensitivity between male and female cells, and a very variable sensitivity from one gene to the next. (J.S.R.)

6430 MATERNAL RADIATION AND CHROMOSOMAL ABERRATIONS. Uchida, Irene A.; Holunga, Roberta; Lawler, Carolyn (Children's Hospital of Winnipeg, Can. Univ. of Manitoba, Winnipeg). Lancet, 2: 1045-9(Nov. 16, 1968).

Children conceived after diagnostic radiation exposure of the mother were compared with children born before exposure. They were matched for maternal age. There were 972 children in each category. A slight decrease was noted in the number of males born after irradiation. Stillbirths were more common among controls, but the maternal age for stillborns in the post-irradiation group was higher. A significantly greater number of trisomic children were born after maternal radiation exposure. Mean maternal ages at time of birth and at time of radiation exposure before birth of children with chromosomal aberrations were significantly greater than those for the entire sample. It was concluded that women exposed to abdominal radiological examinations run an increased risk of producing non-disjunctional offspring, particularly in their late reproductive years. (auth)

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Refer also to abstracts 6217, 6220, 6279, 6318, 6337, 6339, 6340, 6404, 6405, 6528–6532, 6534, and 6606.

6431 (AEC-tr-6965) RESULTS AND CERTAIN ASPECTS OF STUDIES OF CLINICAL DIAGNOSTICS AND RADIATION SICKNESS PROTECTION IN MAN. Gus'kova, A. K. Translated from Med. Radiol., 12: No. 11, 53-64(Nov. 1967). 17p. Dep. CFSTI.

Literature on radiation injuries of man is reviewed with emphasis on Soviet publications during the past ten years. It is pointed out that the accumulated data show that radiation may be used by industry without presenting undue hazards to workers or the general population. An analysis of data on radiation injuries to man showed that they resulted from a disregard of safety procedures for the transportation, storage, and use of radiation sources or because of inadequate shielding or monitoring. The history of scientific research on the clinical effects of radiation and the diagnosis and treatment of radiation injuries is reviewed. (29 references.) (C.H.)

6432 (ANL-Trans-672) EXPERIMENTAL ANIMAL STUDIES ON THE THOROTRAST PROBLEM. Heyder, Joachim (Frankfurt Univ. (West Germany)). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from a Thesis. 72p. Dep. CFSTI.

Factors influencing calculations of the radiation dose in patients twenty years following the administration of Thorotrast (colloidal ThO_2 containing ^{232}Th) were investigated. Experiments on rabbits were used to determine the time required to reach physiological equilibrium following the injection of Thorotrast. Data are included on the activity of ^{232}Th and its decay products found in Thorotrast, chronological changes in the activity of radionuclides in the decay series, and methods used to measure the activity of the decay products of ^{232}Th, including ^{228}Ra, ^{228}Ac, ^{228}Th, ^{224}Ra, ^{212}Pb, ^{212}Bi, and ^{208}Tl in extirpated organs of rabbits. It is pointed out that in the first days following injection these radionuclides are present in various amounts in tissues thus requiring the measurement of the activities of a mixture of α, β, and γ radiations of different energies. Results of the animal studies showed that physiological equilibrium between the activities of the decay products of ^{232}Th was attained after approximately 20 days. Data are presented on the distribution of the various radionuclides and activity ratio in the reticuloendothelial system and bones of rabbits during the first 222 days following injection and carcinogenic and other pathological effects of Thorotrast in rabbits. It is pointed out that the ^{228}Ra activity remains unchanged because of its long half-life. (198 references.) (C.H.)

6433 (BNWL-714) PACIFIC NORTHWEST LABORATORY ANNUAL REPORT FOR 1967 TO THE USAEC DIVISION OF BIOLOGY AND MEDICINE. VOLUME I. BIOLOGICAL SCIENCES, Thompson, R. C.; Teal, Paulette; Swezea, Evelyn G. (eds.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1968. Contract AT(45-1)-1830. 261p. Dep. CFSTI.

The status of research projects in the Division of Biology and Medicine at Battelle-Northwest is reported. The research activities in the following areas are included: radiation effects studies; ^{90}Sr studies in miniature swine; inhalation studies; space nuclear systems studies; radioelement toxicity studies; radioelement removal studies; molecular and cellular level studies; terrestrial ecology studies; and aquatic ecology studies. Separate abstracts were prepared on all nine of the areas of investigation. (E.R.B.)

For abstracts of individual sections see: 6339–6342, 6404, 6405, 6434, 6564, and 6565.

6434 (BNWL-714, pp 6.1-21) RADIOELEMENT REMOVAL STUDIES. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

PLUTONIUM-239 —removal from skin and wounds, effects of DTPA on
—removal of plutonium oxide particle-incorporated, from lungs of dogs and rats following inhalation, effectiveness of pharmaceuticals for
PLUTONIUM OXIDES PuO_2 —phagocytosis of particles of, by reticulo-endothelial cells in rats
PROMETHIUM-147 —excretion by rats, effects of DTPA on (C.H.)

6435 (BNWL-SA-2049) COMPOSITE ENVIRONMENTAL DOSE ESTIMATES. Corley, J. P.; Essig, T. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 25, 1968. Contract AT(45-1)-1830. 19p. (CONF-680930-4). Dep. CFSTI.

From Electromagnetic Spectrum Conference, Richland, Wash.

The population doses received from radionuclides released to the environs are superimposed on those from natural radiation sources plus a minor contribution from weapons testing fallout. Valid estimates of these doses require a knowledge not only of external radiation levels, but also of the kinds and quantities of radionuclides present in the atmosphere and in foods and beverages, and to what extent these radionuclides are transmitted to man through the food chains. Both the control of industrial plant effluents and the evaluation of an environmental situation arising from the releases of such effluents require comparison of measured or calculated values against appropriate standards. Water and air quality standards for non-radioactive contaminants are generally in terms of concentration limits. Standards for radiation protection, however, are based on accumulated radiation doses over an extended period of time. In order to quantify the effects of various radionuclides on the different organs of the human body, the International Commission on Radiological Protection has adopted the concept of a standard man, with assigned biological and physical parameters. The primary radiation dose standards have been translated into secondary standards (Maximum Permissible Body Burdens) and tertiary standards (Maximum Permissible Concentrations in air and water) as additional tools for evaluation. Using the same parameters, one can convert the intake of any one radionuclide into radiation dose. The ingested amount of a radionuclide can be estimated by multiplying the concentrations of the radionuclide in beverages and foods by the consumption rates. The intakes of several radionuclides cannot be combined directly, since each radionuclide results in a numerically different dose per unit intake for each body organ. The total dose received by a body organ of interest is obtained by adding the doses resulting from each radionuclide ingested to the dose resulting from sources external to the body. This total dose can then be compared with appropriate dose standards. (auth)

6436 (N-68-23396) [RADIATION MEASUREMENT OF RADIOBIOLOGICAL HAZARDS OF MAN IN SPACE]. Semiannual Report, October 1, 1967–March 31, 1968. Baily, Norman A. (Emory Univ., Atlanta, Ga.). 55p. (NASA-CR-94575). CFSTI.

Isodose patterns, cyclotron experiments on parasitic organisms, microdosimetric distributions, and energy event frequency distributions were studied in relation to radiobiological hazards to men exposed to space environments. Equipment for the cyclotron work was acquired and constructed, and tissue-equivalent absorbers were constructed for use with the tissue-equivalent proportional counter so that microdose distributions at various tissue depths

could be studied. Measurement and characteristics of depth dose patterns due to proton beams were studied; and the absorbed dose by animals or humans subjected to irradiation was found to be dependent upon the organ or region under consideration, beam geometry, material through which the beam passes prior to incidence on the subject, and other factors peculiar to the particular case under investigation. A computer program was designed to use experimental depth dose data to produce isodose curves, that were computed for proton energies between 45.8 and 730 MeV. (STAR)

6437 (NIRS–18) RADIOACTIVITY SURVEY DATA IN JAPAN. Number 18. (National Inst. of Radiological Sciences, Chiba (Japan)). Feb. 1968. 31p. Dep.

Data collected from routine surveys (1965 to 1968) of radioactivity in diet, human urine, river sediment, soil, and water in Japan are presented in tabular form. A separate section gives tables of data on the seventh nuclear test of the People's Republic of China, including both dietary and meteorological data. (C.O.)

6438 (NP–17667) RADIATION EXPOSURE OF URANIUM MINERS. (National Research Council, Washington, D. C. Div. of Medical Sciences). Aug. 1968. 31p.

The empiric approach using epidemiologic data represents the best basis for establishment of guidance for exposure of uranium miners. This approach at present necessarily assumes that the cumulated exposure to radon and its daughter products, based on measurement or estimate of mine air and expressed in Working Level Months (WLM), bears a constant relationship to the radiation dose to the critical tissue. Uncertainties in regard to estimations of working levels and of absorbed dose to tissue caused by inadequate physical measurements of mine air and a lack of knowledge concerning physical and physiologic processes in the lung are discussed. The hypothesis is favored, pending more definitive data, that radiation exposure contributed to the excess lung cancer observed in the miners in the 100 to 400 CWLM category. Existing data strongly suggest that cigarette smokers among the uranium miners are particularly susceptible to lung cancer. (auth) (TSS)

6439 (NP-tr–1710) FALLOUT IN RAIN, DUST, AND SOIL AND ITS ABSORPTION BY PLANTS: MEASUREMENTS FOR 1965. Nagel, E.; Courvoisier, P. Translated by C. R. Brightmore (Atomic Energy Research Establishment, Harwell, Eng.), from report EIR-TM-SU–96. 5p. Dep.

Data are presented on the content of ^{137}Cs and ^{90}Sr from fallout in samples of barley, wheat, and potatoes collected in Switzerland during 1965. Results are compared with measurements of activity on perspex plates smeared with vaseline and in samples of rainwater collected during the same period. (C.H.)

6440 (NSJ-tr–100) DERIVATION OF THE WORKING LIMITS OF THE SKIN SURFACE CONTAMINATION. Minami, Kentaro; Fukuda, Seiji. Translated from Hoken Butsuri, 1: No. 1, 20-30(1966). 23p. Dep. JCL $2.60 fs, $1.10 mf.

Contamination limits on the skin surface employed as a guide for the radiation protection of occupationally exposed individuals are derived by taking into account the external exposure dose to the skin and the internal exposure dose received by the inhalation, ingestion, and skin penetration of the contaminants. The adequacy of the derived permissible limits for occupational exposure is discussed in relation to the performance probability of a hand-foot monitor for the measurement of hand contamination. The contamination limits for the skin that were adopted by the ICRP, are reviewed together with the general basis of the derivation. (auth)

6441 (NSJ-tr–111) SKIN CONTAMINATION BY RADIOISOTOPES. IV. PIG SKIN CONTAMINATION BY ^{35}S, ^{125}Sb, ^{147}Pm, ^{204}Tl, AND ^{210}Po. Tashiro, Shingo; Wadachi, Yoshiki; Muramatsu, Mitsuo. Translated from Nippon Genshiryoku Gakkaishi, 8: 642-4(Dec. 1966). 6p. Dep.

Experiments were carried out to determine the surface and internal contaminations in layers of fresh pig skin following the application of aqueous solutions of ^{35}S, ^{125}Sb, ^{147}Pm, ^{204}Tl, and ^{210}Po for various periods of time. It was determined that Tl^{+} is cationic, $S(SO_4^{2-})$ is anionic, and Sb^{3+}, Pm^{3+}, and Po^{4+} are radiocolloidal in their mode of skin uptake. The last three showed distinctive skin contaminations in the acidity regions studied. It was found that internal contamination was almost negligible, regardless of contaminant species, acidity, or contact time. (auth)

6442 (NSJ-tr–118) ESTIMATION OF PERSONAL NEUTRON DOSE IN NUCLEAR ACCIDENTS. Ohta, Yukiko. Translated from Nippon Genshiryoku Gakkaishi, 9: 192-9(Apr. 1967). 20p. Dep.

In the case of a nuclear accident, it is important to quickly know personal exposure doses. In spite of the recent advances in physical dosimetry, the detection of neutron exposure dose is not always possible, because of the absence of an adequate system of physical dosimetry. Information concerning the effects of various neutron exposure doses on human hair, nails, and blood was used as a convenient method of detecting unexpected exposure. The most easily detectable nuclides in the hair were ^{24}Na, ^{56}Mn, ^{64}Cu, and ^{32}P. In case of serum, ^{24}Na was the element most easily detected, while ^{24}Na, ^{56}Mn, ^{64}Cu, and ^{32}P were found in the nails. The production of ^{32}P was the result of $^{32}S(n,p)^{32}P$ reaction with fast neutrons, while the other nuclides were produced mainly with thermal neutrons. The effect of competing reactions was found to be negligibly small. In order to know the content of each element in the human hair, nails, and blood, neutron activation analyses of ^{24}Na, ^{56}Mn, ^{64}Cu, ^{38}Cl, and ^{32}P were carried out. The detectable limits for 1 g of hair were 5 rem for thermal neutron exposure and 60 rem for fast neutron exposure. The result of this study showed that the hair is a useful detector for estimating the fast and thermal neutron exposure doses in the case of nuclear accident. (auth)

6443 (NYO–3446-11, pp 1-15) ^{55}Fe IN LAPPS AND SOUTHERN FINNS AND THEIR DIET. Jaakkola, Timo (Helinski Univ. (Finland). Dept. of Radiochemistry). (CONF-671062–1).

From 4th Symposium on Radioactivity in Scandinavia, Olso, Norway.

Considerable amounts of ^{55}Fe were released to the environment by large nuclear tests carried out during 1961 and 1962. Consequently, the transport of ^{55}Fe through food chains to man residing in Finland was studied. Data are presented on the content of ^{55}Fe in lichens, reindeer meat, fish, potatoes, white flour, rye flour, and beef. The ratio of ^{55}Fe to ^{137}Cs in fish and meats was measured. The ^{55}Fe content of blood samples collected in 1966 from 140 individuals; the ratio of ^{55}Fe to ^{137}Cs in blood samples; and the effects of diet, age, and sex on the content of ^{55}Fe in blood samples were determined. It was estimated that the annual radiation dose to hematopoietic tissues from ^{55}Fe in 1966 was 19 mRad for Lapps and 2 mRad for southern Finns. (C.H.)

6444 (NYO–3446-11, pp 16-22) ^{55}Fe IN ORGANS OF REINDEER, ELK, AND FISH AND IN VEGETATION, ANALYZED DURING 1967 AND 1968. Jaakkola, Timo; Miettinen, Jorma K. (Helsinki Univ. (Finland). Dept. of Radiochemistry).

Data are presented on the content of ^{55}Fe in meats from elk and reindeer, fish, and lichens and other plants in Finland during 1967 and 1968. (C.H.)

6445 (NYO–3446-11, pp 23-34) ^{137}Cs IN MAN, ANIMALS, AND PLANTS IN LAPLAND AND IN SOUTHERN FINLAND. Rahola, Tua; Miettinen, J. K. (Helsinki Univ. (Finland). Dept. of Radiochemistry). (CONF-671062–2).

From 4th Symposium on Radioactivity in Scandinavia, Oslo, Norway.

The ^{137}Cs content of 47 Lapps residing in northern Finland was measured by whole-body counting in 1966 and again in 1967. An average decrease of 27.1% was noted. The sharp decrease in ^{137}Cs content was attributed to a change in the eating habits of reindeer caused by the devastation of hill birch forests by an insect and the substitution of wood hair grass for birch leaves and lichens in the diet of reindeers in the area. Data are included on the content of ^{137}Cs in meat from reindeer, in tissues of wolf and wolverine, and in lichens and higher plants sampled during 1966 and 1967. (C.H.)

6446 (NYO–3446-11, pp 35-41) ^{137}Cs AND ^{90}Sr IN BLOOD AND URINE OF LAPPS AND SOUTHERN FINNS COMPARED WITH THE TOTAL BODY BURDEN OF ^{137}Cs AND THE ESTIMATED DIETARY INTAKE OF ^{90}Sr. Jaakkola, Timo; Miettinen, J. K.; Haesaenen, Erkki; Romantschuk, Hakan (Helsinki Univ. (Finland). Dept. of Radiochemistry). (CONF-671062–3).

From 4th Symposium on Radioactivity in Scandinavia, Olso, Norway.

The content of ^{137}Cs and ^{90}Sr was determined in samples of blood and urine of two populations in Finland. Samples were obtained from reindeer herding Lapps in 1966 and from southern Finns in 1964. The results are compared with the respective whole-body levels of ^{137}Cs in the same subjects and with the calculated dietary intakes of ^{90}Sr and Ca in the same populations in 1961. (TSS) (auth)

6447 (NYO–3446-11, pp 42-51) BODY BURDEN OF ^{137}Cs IN FINNISH LAPPS IN SPRING 1968. Miettinen, Jorma K.; Rahola, Tua (Helsinki Univ. (Finland). Dept. of Radiochemistry).

Results of whole-body counting of ^{137}Cs in Finnish Lapps in the spring of 1968 are compared with data from annual measurements since 1961. The data indicate a biological half-life of 4.3 years for ^{137}Cs in man. Cesium-137 measurements in reindeer meat and lichen are presented for the same time period. (C.H.)

6448 (NYO–3446-11, pp 61-7) ^{137}Cs AND ^{210}Po IN ARCTIC FAUNA. Kauranen, P.; Miettinen, J. K. (Helsinki Univ. (Finland). Dept. of Radiochemistry).

Preliminary data are presented from measurements of ^{137}Cs and ^{210}Po contents of Arctic birds and mammals. Data are included for various tissues from two species of ptarmigan and from lynx, wolves, and wolverines in northern Finland. Values of 1968 samples were 30 to 50 percent of the 1966 values in Lappland and one percent in southern Finland. (C.H.)

6449 (NYO-3446-11, pp 68-73) ^{210}Po AND ^{210}Pb CONCENTRATIONS IN FISH. Kauranen, Pentti; Miettinen, Jorma K. (Helsinki Univ. (Finland). Dept. of Radiochemistry).

Data are presented on the content of ^{210}Pb and ^{210}Po in fish from the Arctic Ocean and lakes in Finland during 1967. (C.H.)

6450 (PEL-181) ENVIRONMENTAL RADIOACTIVITY AT THE NATIONAL NUCLEAR RESEARCH CENTRE, PELINDABA. Report for the Year 1967. van As, D.; Fourie, H. O.; Vleggaar, Constance M. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Aug. 1967. 20p. Dep. CFSTI.

Levels of environmental activity from nuclear explosions during 1967 are summarized. Tables are presented to show α and β activities from ^{90}Sr, ^{137}Cs, and ^{40}K in soil; β activity from ^{141}Ce, ^{144}Ce, ^{103}Ru, and ^{95}Zr in vegetation; and α and β activity from ^{137}Cs, ^{40}K, and ^{90}Sr in fish, plankton, sediment, and water. Results of the monitoring program showed no increase in environmental radioactivity originating from the operations at the National Nuclear Research Centre at Pelindaba. Increases that were found were the result of increased levels of fallout from nuclear bomb tests conducted in the South Pacific. Gross activities are compared with the values of previous years. (H.L.W.)

6451 (PHS-PUBL-1224) ENVIRONMENTAL RADIATION SURVEILLANCE. Nelson, Donald J. Jr.; Snow, Donald L. (National Center for Radiological Health, Rockville, Md.). [1966]. 11p. GPO.

The environmental radiation surveillance program of the National Center for Radiological Health of the U. S. Public Health Service is discussed. In cooperation with other Federal agencies and State and local health departments, the Service operates several distinct networks to monitor the successive environmental stages through which radionuclides reach man. The program includes the sampling and analysis of air particulates collected at 74 stations distributed throughout the 50 States, Puerto Rico, Guam, and the Canal Zone for gross β radioactivity to provide indications of any increase of activity in the environment caused by fallout or other sources; the analysis of samples of milk collected at more than 60 stations, with at least one in each State plus Puerto Rico and the Canal Zone; sampling of the total diet at 29 institutions for radioactivity; analysis of samples of human bone for ^{90}Sr; analysis of bovine thyroid glands for ^{131}I; and analysis of samples of caribou and reindeer meat collected in Alaska for ^{137}Cs. In addition, the Service participates in a number of special radiological safety projects that involve sampling environmental media. These projects are concerned with the construction and operation of nuclear powered ships, investigation of river and port environments associated with nuclear reactor operations, and off-site monitoring in support of nuclear device testing and aerospace nuclear activities. The Service also provides guidance to health authorities and reactor personnel in problems of nuclear waste management and provides assistance in the event of accidents involving radioactive materials and nuclear weapons. (C.H.)

6452 (UCRL-Trans-1357) METHODS FOR CALCULATING AND OBTAINING SOME DOSE DISTRIBUTIONS FAVORABLE FOR DEEP THERAPY WITH HIGH ENERGY PROTONS. Karlsson, Bengt G. Translated by F. S. Freisinger for Univ. of California Lawrence Radiation Lab., Berkeley, from Strahlentherapie, 124: 481-92(1964). 34p. Dep. CFSTI. JCL $3.60 fs, $1.22 mf.

Methods for calculating the radiation dose from high-energy protons using ionization chambers are discussed. Methods are described for obtaining favorable dose distributions for therapeutic doses of protons by means of a water absorber and a vane-type filter made of rods of heavy metal. A uniform dose in the entire pelvic region during irradiation of genital carcinomas was obtained by this method. (C.H.)

6453 (Y-OA-212) RESEARCH AND DEVELOPMENT SAFETY. Hoy, H. C. (Union Carbide Corp., Oak Ridge, Tenn.). Oct. 28, 1968. Contract W-7405-eng-26. 5p. (CONF-681023-1). Dep. CFSTI.

From National Safety Congress, Chicago, Ill.

The problem of health and safety in research and development is considered. The code of ethics for engineers is discussed. (W.H.K.)

6454 BASIC NORMS FOR HEALTH PROTECTION OF THE POPULATION AND INDUSTRIAL PERSONNEL AGAINST HAZARDS OF IONIZING RADIATION. Radiation Protection Norms. Brussels, European Atomic Energy Community, 1967. 168p. (In Several Languages).

The basic norms for health protection against ionizing radiation, as promulgated by the European Atomic Energy Commission, are compiled in German, French, Italian, and Dutch. Definitions of terms are given and the range of applicability of the standards is outlined. The highest permissible doses, exposures, and contaminations are summarized. The principles of health monitoring of workers are given. In an appendix the highest permissible concentrations of the radioisotopes are tabulated. (J.S.R.)

6455 COMMENT ON SOME PRINCIPLES OF RADIATION PROTECTION. Makedanz, A. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Isotopenpraxis, 4: 235-9(June 1968). (In German).

Some comments and explanations are presented on principles formulated in section 15 of the Radiation Protection Ordinance of the German Federal Republic. Planning is emphasized as an integral component of radiation protection. The relation between cost and dose output is to be considered in the planning. Protective agents and the identification of radioactive materials are discussed. The requirements with respect to work clothes, behavior, and regulations are outlined. (J.S.R.)

6456 PUBLIC HEALTH AND THE MEDICAL USE OF IONIZING RADIATION. FIFTH REPORT OF THE WHO EXPERT COMMITTEE ON RADIATION. World Health Organ., Tech. Rep. Ser., No. 306, 3-41(1965).

The collective views of an international group of experts regarding public health aspects of the uses of ionizing radiation in medicine are presented. It is pointed out that exposure of the population to ionizing radiation may arise from the diagnostic use of x rays, the diagnostic use of radioisotopes, and the therapeutic use of x rays and other sources of ionizing radiation, and that recent advances in both radiodiagnosis and radiotherapy have resulted in a great increase in the use of radiation in medicine. Emphasis is placed on the precept that all medical uses of ionizing radiation should give the greatest value in terms of relevant diagnostic information or therapeutic effect with the smallest reasonable dose to the patient. Procedures that will ensure the efficient and safe uses of ionizing radiation in medicine are discussed. (auth)

6457 EVALUATION OF RADIATION DOSE IN POPULATION IN FALLOUT CONTAMINATED AREA. Mikhailov, M. G.; Bonev, L. E.; Andreev, E. A. (Scientific Research Inst. of Radiology and Radiation Protection, Moscow). Rentgenol. Radiol., 7: 168-73 (1968). (In Russian).

A brief review of the protection of population against the effects of ionizing radiation in fallout-contaminated areas is given. Shelters and other means of protection against nuclear attack are discussed. (R.V.J.)

6458 STUDIES IN WORKMEN'S COMPENSATION AND RADIATION INJURY. VOLUME II. THE INCIDENCE, NATURE, AND ADJUDICATION OF WORKMEN'S COMPENSATION CLAIMS INVOLVING RADIATION EXPOSURE AND DELAYED INJURY. O'Toole, Thomas J. Washington, D. C., Department of Labor and Washington, D. C., Atomic Energy Commission, 1965. 100p. Available free from Office of General Manager, DTIW.

Cases involving delayed injury or disease alleged to have been caused by work-connected exposure to ionizing radiations for which application was made for workmen's compensation are reviewed. Abstracts are presented of relevant common law cases and their disposition in the U.S.A. and Canada up to 1965. (C.H.)

6459 COMMENTS ON RECENT PROPOSALS FOR REGULATORY CONTROL OF X-RAY EXPOSURES. Tolan, John H. (Univ. of Missouri, Columbia). Radiol. Technol, 40: 124-34 (Nov. 1968).

The status of Federal legislation regarding the control of radiation dose to patients during diagnostic radiography is discussed. Proposed legislation is reviewed and recommendations of various interested groups as to inclusions are presented. Emphasis is placed on standards for the manufacture and inspection of x-ray equipment and standards for the training of radiologic technologists. (C.H.)

6460 ENDOCURIETHERAPY: A DOSIMETRIC STUDY OF TWO PARALLEL RADIOACTIVE SOURCES. Pierquin, B. (Institut Gustave Roussy, Villejuif, France); Dutreix, A.; Paine, C.; Chassagne, D.; Wambersie, A. Acta Radiol., Ther., Phys., Biol., 7: 193-201(June 1968).

A systematic study of the dosimetry around two straight, parallel radioactive sources of equal length was made by the aid of a computer with the aim to provide basic information for setting up preliminary distribution plans enabling the techniques used in curie therapy to be applied to the best advantage. Simple

relationships between the three dimensions of the treatment volume and the disposition of the radioactive material could be established and these will form the fundamental starting point for a study of more complex arrangements. (auth)

6461 EMPIRICAL FORMULAS FOR TISSUE CORRECTION FACTORS IN COBALT TELETHERAPY. Spring, Erik; Anttila, Pentti (Univ. Central Hospital, Helsinki). Acta Radiol., Ther., Phys., Biol., 7: 230-7(June 1968).

A study was performed with the aim of finding simple mathematical expressions for the per cent depth doses for ^{60}Co γ teletherapy when pulmonary tissues are included. Three formulas are presented that fulfil the requirements for application in treatment planning using computers. (auth)

6462 DANGERS FROM IONISING RADIATIONS ASSOCIATED WITH SPACE FLIGHTS CARRIED OUT WITH HUMAN CREWS. NOTE I. NOTES ON IONISING RADIATIONS IN EXTRA-TERRESTIAL SPACE. Agati, G.; Judica-Cordiglia, A. (Univ., Turin). Minerva Radiol., 13: 324-34(June 1968). (In Italian).

The risks arising from space flights carried out with human crews are considered and reference is made to the composition and the intensity of geo-atmospheric and extra-terrestrial space radiations. In the case of extraatmospheric cosmic radiation, a distinction is drawn between primary cosmic radiation, solar radiation, radiation from the Van Allen belt, and from auroras. Future astrophysical research programs are briefly discussed and data on crew exposure to ionizing radiation during the first space flights are presented. (auth)

6463 RADIATION PROTECTION OF PERSONNEL AGAINST APPLICATIONS OF NUCLEAR ENERGY IN INDUSTRY AND MEDICINE. Kiefer, H. (Kernforschungszentrum, Karlsruhe, Ger.). Therapiewoche, 17: 2124-6(Dec. 20, 1967). (In German).

The principal radiation protection measures are briefly described. The problem of open radioactive material is considered. Contamination by radioactive emitters and the indirect methods necessary for the determination of α and β incorporation are discussed. The success of radiation protection methods is illustrated by figures from German experience. (J.S.R.)

6464 PROTECTION OF THE POPULATION AGAINST THE PEACEFUL USES OF ATOMIC ENERGY. Semiller, H. A. (Europaeische Atomgemeinschaft, Brussels). Therapiewoche, 17: 2122-3(Dec. 20, 1967). (In German).

The applications of nuclear energy are given and the possible dangers to the population are summarized. The precautions taken to protect the population in the construction and operation of a nuclear power plant are given. (J.S.R.)

6465 DETERMINATION OF EFFECTIVE HALF-LIFE OF ^{103}Ru IN MAN AFTER INHALATION. Pusch, W. M. Health Phys., 15: 515-17(Dec. 1968).

Seven persons who had become accidentally contaminated with ^{103}Ru were measured by whole body counting. The effective half-life of burdens in the chest was calculated from the decrease of the retention and found to be 26.6 days. This is not in good accord with that reported in other papers. (INIS) (UK)

6466 PROBLEMS OF PROTECTION OF PHYSICIANS IN NUCLEAR ENERGY INSTALLATIONS. Moehrle, G. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). Therapiewoche, 17: 2126-8(Dec. 10, 1967). (In German).

One of the most important tasks of health physics physicians is the health monitoring of professionally exposed persons. The primary problems in this area are briefly indicated. The second task of the physician is the treatment of radiation-injured persons. The steps to be taken in cases of exposure are outlined. (J.S.R.)

6467 ASSESSMENT OF THE LEVELS OF IRRADIATION OF THE PERSONNEL BY MEANS OF THE IPC (INDIVIDUAL PHOTO CONTROL) METHOD IN CERTAIN BRANCHES OF SCIENCE AND TECHNIQUE. Moiseitsev, P. I.; Korenkov, I. P. Gig. Sanit., No. 9, 59-61(Sept. 1968). (In Russian).

Tabulated data are given on assessments of radiation levels in various personnel handling radioisotopes in laboratories or personnel exposed to γ radiation in various installations (nuclear reactors, accelerators, radioisotope instrumentation, γ defectoscopy, etc.). (R.V.J.)

6468 DECREASE OF IRRADIATION INTENSITY BY THE PROPER CHOICE OF ISOTOPES. Kostenko, V. T. Gig. Sanit., No. 9, 90-1(Sept. 1968). (In Russian).

An attempt was made to compare radiation effects on personnel handling different γ ray sources and to assess the level of irradiation from various isotopes used in industrial γ defectoscopy. Graphs of the personnel radiation levels made during 1959 to 1961 and 1961 to 1967 show the advantages of ^{192}Ir and ^{137}Cs isotopes over ^{60}Co. (R.V.J.)

6469 FEATURES OF ^{32}P "BREMSSTRAHLUNG" IN TISSUE EQUIVALENT MATERIAL: EXPERIMENTAL DOSIMETRY. Pozza, F.; Ravasini, R.; Monasta, G.; Gortenuti, G. (Univ., Padua). Acta Isotop., 7: 261-70(Dec. 30, 1967). (In Italian).

The results of the mean energy value of Bremsstrahlung photons from ^{32}P in tissue-equivalent material were reported. From the counting of BS photons it was possible to determine the β-radioactivity level of the emitting source. These figures were obtained by means of a computer, taking into consideration various geometrical conditions of the emitting source and of the probe. Some examples of these values are presented in a table. (auth)

6470 DOSIMETRY OF ULTRA-HIGH DOSE RATE. Worsnop, B. R. (Univ. of California, San Francisco). pp 124-7 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

Work in progress is reported on dosimetric methods being used to determine whether at dose rates of electrons above 10^6 rads/sec there is a change in type of damage, recovery pattern, or oxygen effect on mammalian cells. The initial experiments are on Escherichia coli because this organism approaches mammalian cells in its behavior, is easy to quantitate, and is easily used in the field. (M.M.B.)

6471 RBE IN DEPTH OF HIGH-ENERGY ELECTRONS USING CELL CULTURES. Robinson, E. (Univ. of Maryland, University Park). pp 116-23 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

Experiments were conducted with human cells in vitro in an attempt to determine the relative biological efficiency of 35 MeV electrons at relative depth dose positions ranging from the 100% to the 9% levels, and 15 MeV electrons at the 100% level. The data indicate that there is little or no effect of phantom depth on RBE between these levels, and little or no difference in the RBE values at the maximum of the depth dose distribution for 35 and 15 MeV electrons. (auth)

6472 RBE AS A FUNCTION OF DEPTH IN HIGH-ENERGY ELECTRON AND PHOTON BEAMS. Wambersie, A.; Dutreix, A. (Institut Gustave-Roussy, Villejuif, France). pp 104-15 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

The RBE of a 20 MeV electron beam produced by an Allis-Chalmers betatron was tested for the survival of bacteria and diploid yeast. Variation of RBE with depth in the beam was investigated. No variation was observed with depth of the electron beam, but since higher organisms may be more sensitive to variations in LET, extrapolation to mammalian cells may not be valid. Bacteria exhibited a one target survival curve and the yeast a two target curve. Some variation of the RBE of photon beams as a function of energy was observed. However, it was concluded that in a photon beam it is unlikely that variation in effective energy, or in the electron spectrum in depth, is sufficient to modify the RBE enough to have practical significance. (M.M.B.)

6473 DANGERS OF IRRADIATION IN A SPACE FLIGHT ENVIRONMENT. APPLICATION TO AN EARTH-MOON PROJECT. Genet, Michel (Institut de Physique Nucleaire, Paris). Radioprotection, 3: 115-29(1968). (In French).

The radiation doses that cosmonauts would receive during a space flight to the moon were estimated on the basis of the different types of radiations encountered in space. These various risks are envisaged in a general fashion and applied particularly to the case of an earth–moon project. From this analysis it is determined that the principal danger comes from cosmic rays emitted by solar eruptions. In effect, the dose equivalents deduced from these solar proton fluxes can be, even at the interior of the space cabin, several hundred Rem. The detection and possible means of protection against this type of radiation are discussed. (tr-auth)

6474 A DOCUMENT ON THE NOTION OF "DOSE" WITH THE IRRADIATED MAN. Le Go, Roland (CEN, Fontenay-aux-Roses, France). Radioprotection, 3: 97-113(1968). (In French).

An attempt was made to introduce in the radiation dose concept for man a biological significance by showing that one can calculate successively: a dose to the body phantom which can be represented spatially by the transparent mannequin; a physical dose to the bone marrow, or mean homogeneous medullary dose (MHMD); and a dose expressing the injury to the cell layers, or medullary dose biological equivalent (MDBE). The tridimensional representation in the transparent mannequin facilitates the direct observation of the distribution of the physical doses, particularly at the level of the critical organs, principally the marrow. It gives, moreover, a geometric basis for further calculations. The MHMD is representative of the total physical energy, transmitted to the bone marrow, because of its topographic distribution. It can not be used as biological reference for hematological reactions, but it can probably be related to some biological tests expressing the primary cellular lesions, such as chromosome lesions. The MDBE is a value whose calculation is based on the rate of survival of cell layers of the marrow. This value seeks to be representative of the evolution of hematological cells when the marrow is the critical organ. It introduces the concept of critical cell as a necessary basis for comparison between the effects of various doses. It is the MDBE which can be used as a reference to estimate the changes of survival rate. (tr-auth)

6475 PUBLIC HEALTH ASPECTS OF GALACTIC RADIATION EXPOSURE AT SUPERSONIC TRANSPORT ALTITUDES. Schaefer, Hermann J. (Naval Aerospace Medical Inst., Pensacola, Fla.). Aerosp. Med., 39: 1298-1303(Dec. 1968).

Although the galactic radiation level at SST altitudes is such that, from a radiological standpoint, exposure appears entirely unobjectionable, the prospect of large-scale commercial passenger operations calls for accurate assessment of the radiation load to the individual crew member and passenger and to the population as a whole. The maximum dose rate of about 1 milli-Rem/hour at 65,000 feet in the polar region for 600 hours per year at altitude leads to a yearly dose of 0.6 Rem, which exceeds the Maximum Permissible Dose (MPD) for "Members of the Public" (0.5 Rem/year) by 20% but constitutes only 12% of the MPD for Radiation Workers (5 Rem/year) in terms of official regulations. On the other hand, shifting all jet travel to SST altitudes would still keep the additional radiation burden for the total population at the level of a few per cent of the fallout exposure although the individual passenger would accumulate the yearly fallout dose in about 25 hours at altitude. Radiobiologically, special consideration has to be given to heavy nuclei because of their high values of Linear Energy Transfer (microbeams). However, the small fraction of the heavy flux, which carries the microbeam effects, undergoes a substantially higher absorption in the atmosphere than does the total flux. The microbeam effectiveness of galactic primaries, therefore, is virtually extinguished at SST altitudes. (auth)

6476 FRIGHTENING THE PUBLIC ABOUT RADIATION. J. Med. Soc. N. J., 65: 47(Feb. 1968).

Alarming unofficial public statements on the hazards of medical diagnostic radiation exposure are considered with reference to the assessment of these hazards by federal agencies. It is pointed out that the public was alarmed by the recent statement of a physicist that thousands of deaths result annually from radiation exposures from routine diagnostic x-ray examinations. It was asserted that 3500 to 29,000 deaths a year resulted from radiation damage from diagnostic medical exposure. In contrast, a recent nationwide survey by the U. S. Public Health Service concluded that medical x-ray uses account for only half as much exposure as the average American receives annually from natural background sources. The medical exposure to reproductive organs was estimated at 55 mrem and the average background exposure of Americans at 120 mrem/yr (from natural radioactivity in the soil, cosmic rays, and in body radionuclides such as ^{40}K). The need for diagnostic information by a patient's physician is the only sound reason for subjecting a patient to an x-ray examination. Radiologists have a direct responsibility to see that x-ray examinations are done efficiently and safely so that the maximum benefit is attained with the minimum risk to all concerned. (BBB)

6477 RADIATION SAFETY AND CONTROL IN VIRGINIA: A DEVELOPING PROGRAM. Shanholtz, Mack I. (State Dept. of Health, Richmond, Va.). Va. Med. Mon., 95: 113(Feb. 1968).

Criteria for establishment of radiation safety and control are discussed. The application of parameters of radiation protection that include time, distance, shielding, surveying, and monitoring reduces radiation exposures to acceptable limits. These principles and practices will be the general basis for complying with maximum allowable exposure criteria incorporated in future regulations. It will be incumbent upon the user to provide whatever action is necessary to assure that under normal continuous operating conditions no person will be exposed to radiation or radioactive materials approaching the maximum allowable values. Such a program will widen the gap between the alternatives of benefit vs risk in favor of the benefits hoped for when radiation dosage is prescribed by the physician. (BBB)

6478 RADIATION SAFETY. Josine, M. Radiol. Technol., 38: 188-9(Nov. 1966).

The role of radiologic technologists in civil defense is discussed. Effects of thermonuclear weapons explosions are also considered, particularly the hazards from fallout. Radiologic technicians would be in a better position than most citizens to assess these dangers. The greatest hazard from multinuclear-weapon explosions would be the residual radiation or radioactive fallout that would cover even those areas not under attack. Humans could receive up to 200 R radiation doses without suffering disabling illness; however, if the dose exceeded 200 R and was received during several days, radiation sickness would develop. If received over a short period of time, such doses would cause death. After detonation of a nuclear weapon, the radiation intensity would decline by a factor of ten for every seven-fold increase in time. Fallout shelters offer the single best defensive shielding action for the protection of the greatest number of people. How radiologic technicians could assist in the civil defense program is outlined. (BBB)

6479 LEGAL ASPECTS OF FOOD IRRADIATION. Vergragt, J. H. (Tijdschrift voor Diergeneeskunde, Utrecht). Tijdschr. Diergeneesk., 92: Suppl. 1, 55-63(1967). (In Dutch).

The legal aspects concern the rules to be adopted in reducing the risk of damage due to irradiation of food to a minimum. Unlike the rules that are widely accepted and that are repressive in character, a preventive system would appear to be indicated in this case. A scheme providing that irradiated foods may only be placed on the market after being released does not by itself ensure that products that were not released will not be marketed. Methods for subsequent checking continue to be absent. There are rules of law in the Netherlands, according to which the use of radiation sources is bound to a licensing system. This offers a basis for providing the necessary guarantees. In addition to public health interests, commercial interests play a role in this case. This is particularly apparent in international trade; continued international consultations on the subject will be essential. (auth)

6480 AN EXPERIMENTAL STUDY OF THE RETENTION OF RADIOACTIVE AEROSOL PARTICLES IN THE HUMAN RESPIRATORY TRACT. Reiter, R. Atomkernenergie, 13: 437-43(Nov.-Dec. 1968). (In German).

The retention characteristics of natural radioactive aerosols were studied by observations carried out with a human subject in a mine, and the size-distribution spectrum of the aerosol, and the amount of radon decay products adsorbed on the particles were determined simultaneously. The results obtained are compared with data from a four-stage retention simulator used to ascertain the distribution of inspired aerosol particles with reference to the anatomy of the respiratory tract and the percentage of expired material. The agreement between the two sets of data was found to be quite good; there was, moreover, a conspicuously low retention rate for aerosols with diameters less than 0.2 μm. The results were checked by independent experiments on animal lungs, in which the percentage of total retention for particles with diameters ranging from 0.07 to 2.0 μm was measured. (auth)

6481 EFFECTS OF AQUATIC PLANT SPECIES, SAND, AND DILUTION FACTORS ON PURIFICATION OF WATER FROM ^{137}Cs. (REPORT IV). Agre, A. L.; Molchanova, I. V.; Chekalova, S. N. Byull. Mosk. Obshch. Ispyt. Prir., Otd. Biol., 71: 124-7(Sept.-Oct. 1966). (In Russian).

Experiments were conducted by the use of 24 interconnected tank reservoirs (30- to 35-l capacity) containing water (pH 7.8, Ca content 26 mg/l, Mg 10 mg/l, and Fe 0.16 mg/l) contaminated with 10 μCi/l of ^{137}Cs, as the chloride, and slowly flowing through the upper outlet. Aquatic plant species such as Elodea canadensis, Utricularia vulgaris, Ceratophyllum demersum, Potamogeton, and Cladophora fracta were tested for their influence on the decontamination of water. The 24 tanks were separated by three's into eight series and each series contained a specific and equal amount of washed river sand. The first five series of tanks contained a balanced weight of single aquatic plant species, the sixth series contained a balanced weight of all five plant species, the seventh series contained just sand and water, and the eighth series served as a control unit. It was found that all five aquatic plant species enhanced the purification of water contaminated with ^{137}Cs to approximately the same extent. The presence of sand in the tanks contributed four-fold to the degree of water purification and the presence of aquatic plant species effectively increased

it eight times, as compared with the control results. The coefficient of ^{137}Cs absorption by five species of plants was practically the same. (BBB)

6482 ^{55}Fe IN PACIFIC OCEAN ORGANISMS. Jennings, Charles David. Corvallis, Ore., Oregon State Univ., 1968. 89p. Thesis.

Large quantities of ^{55}Fe, formed by nuclear testing during 1961 and 1962, have been deposited on the North Pacific Ocean as fallout and concentrated by marine organisms. As a result of this high ^{55}Fe fallout and of low concentrations of iron in the ocean, marine organisms are the site of high ^{55}Fe specific activity (^{55}Fe activity/weight of total iron). Iron-55 specific activity was seen to vary among five species of Pacific salmon, with sockeye salmon showing highest and chinook salmon showing lowest ^{55}Fe specific activity. Variation of ^{55}Fe specific activity among species of salmon appears to result from their migration routes and feeding habits. In 1964 at Strait of Juan de Fuca, Canada, where the largest ^{55}Fe specific activity difference between the chinook and sockeye salmon was observed, the ^{55}Fe specific activity of chinook salmon was 0.745 μCi/g Fe and that of sockeye salmon was 28.7 μCi/g Fe. In subsequent years ^{55}Fe in salmon decreased, and from this decrease a sixfold decrease in ^{55}Fe in the surface layer of the ocean corrected for physical decay to the time of initial input, was observed. Assuming an approximately instantaneous input of fallout ^{55}Fe and a first order reaction, the rate constant for the removal of ^{55}Fe from the surface layer of the ocean was calculated to be 0.0603 month^{-1}. Iron-55 removed from the surface layer of the ocean does not reappear in high specific activity in sediments or in benthic organisms, probably because the high stable iron content of sediments dilutes the ^{55}Fe, thus yielding a low ^{55}Fe specific activity. The accumulated input of ^{55}Fe into central Alaska, measured in lichen, was found to be 209 nCi/m^2 and a calculation of the ^{55}Fe present in the North Pacific Ocean from ^{55}Fe specific activity in salmon was found to be 6.1×10^5 nCi/m^2. The assumption that ^{55}Fe is uniformly distributed throughout the ocean, used in the calculation of ^{55}Fe present in the North Pacific Ocean, accounts for part of the discrepancy between these figures. The remaining discrepancy is apparently due to differing amounts of ^{55}Fe laid down as fallout, with the North Pacific Ocean receiving at least ten times as much as Alaska. (Diss. Abstr.)

6483 RADIATION PROTECTION. RECOMMENDATIONS OF THE INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION (AS AMENDED 1959 AND REVISED 1962). ICRP Publication 6. New York, The MacMillan Company, 1964. 74p.

Recommendations of the International Commission on Radiological Protection concerning maximum permissible radiation doses for occupational exposure and for the general population are presented as revised in 1962. The 1958 recommendations of the Commission and the 1959 addendum to the recommendations are included. Basic concepts of radiation protection are reviewed and criteria are included on which the permissible dose for external and internal exposures of man are based. Revised data on maximum permissible radiation doses and on protection against x radiation up to energies of 3 MeV and against β and γ radiation from sealed sources are included. (C.H.)

6484 CALCULATION OF RADIATION DOSE DUE TO PROTONS AND NEUTRONS WITH ENERGIES FROM 0.4 TO 2 GeV. Wright, Harvel A.; Anderson, V. E.; Turner, J. E.; Neufeld, Jacob; Snyder, W. S. (Oak Ridge National Lab., Tenn.). Health Phys., 16: 13-31(Jan. 1969).

Estimates of the distribution of absorbed dose and dose equivalent with depth in a tissue slab were made for irradiation by normally incident and also isotropically incident protons and neutrons with energies up to 2.0 GeV. The Monte Carlo calculations, based on a simplified model for nuclear interactions, took into account the production of pions as well as nucleons in nuclear interactions. The energy deposited due to ionization by charged particles was separated into LET ranges, permitting different quality factors to be used. The total dose was broken down to show the contribution due to ionization by primary particles (in the case of incident protons), ionization by secondary particles, ionization by pions, excitation of residual nuclei following cascades, and the contribution from pions that stopped within the tissue. Results are presented in the form of graphs showing the distribution of absorbed dose and dose equivalent with depth within the phantom for incident energies 0.6, 1.0, and 2.0 GeV. The results appear to be in reasonable agreement with experimental results. There was a rapid buildup of dose near the surface and then a more gradual buildup in the remainder of the 30 cm thick tissue slab. Pions were found to contribute less than 10% of the total dose. For normally incident neutrons the quality factor decreased from near 10 at the surface on which the neutrons were incident to approximately 2.5 near the back of the slab. (auth) (UK)

6485 GAMMA SCATTER FROM OPEN-TOP CELLS. Birchall, Ivan. (Univ. of Liverpool). Health Phys., 16: 47-56(Jan. 1969).

A method of assessing the scatter of gamma radiation from air volumes and structural materials above open topped gamma cells is presented. The calculations involve the summation of the scatter from thin strips of air or other materials and assume that air absorption and multiple scattering are effectively self-cancelling. Comparison with experimental data is given, which shows that the method gives sufficient accuracy for protection purposes. (auth)

Medicine

Refer also to abstracts 6244, 6329, 6430, 6452, 6456, 6459, 6466, 6472, 6476, 6477, 6583, 6599–6601, 6603, and 6606.

6486 (ABCC-TR-26-60) HEMATOLOGICAL FINDINGS FOR CHILDREN EXPOSED IN UTERO–HIROSHIMA. Takamura, Tsugiso; Ueda, Shoichi (Atomic Bomb Casualty Commission, Hiroshima (Japan). National Inst. of Health, Hiroshima (Japan)). [nd]. 17p. (In Japanese and English). Dep. CFSTI.

Hematological data collected between 1950 and 1957 on children of Hiroshima irradiated in utero and nonirradiated children were compared. No changes peculiar to the irradiated group were found. (C.H.)

6487 (ACRH-1000-58) CLINICAL APPLICATION ^{125}I BONE DENSITOMETRY. Strandjord, Nels M.; Forland, Marvin; Lanzl, Lawrence; Cox, Ann (Chicago Univ., Ill.). Apr. 1968. Contract AT(11-1)-69. 10p. (CONF-680435-1). Dep. CFSTI.

From Symposium Ossium, London, England.

Includes Photographs.

Bone densitometry using ^{125}I has been used clinically. Bone density, after reaching a peak, decreased with age in males and females. Females given supplemental estrogens after menopause have a higher bone density than untreated females of a corresponding interval postmenopausal. Seventeen of twenty patients with hyperparathyroidism had significantly decreased bone density as compared to normals of the same age. This method of densitometry in several patients was used to measure the degree of improvement under therapy. (auth)

6488 (ARCH-1000-82) COMPARISON OF ^{68}Ga, ^{99m}Tc, AND ^{113m}In USED WITH THE GAMMA CAMERA AND THE 3-INCH AND 5-INCH SCANNERS FOR VISUALIZATION OF LESIONS IN THE BRAIN, KIDNEY, LIVER, AND LUNG. Lathrop, K. A.; Cohen, T. D.; Beck, R. N.; Harper, P. V. (Argonne Cancer Research Hospital, Chicago, Ill. Chicago Univ., Ill.). Sept. 26, 1968. Contract AT(11-1)-69. 24p. (CONF-680933-1). Dep. CFSTI.

From Nuclear Medicine Meetings, Wiesbaden, Germany.

A method is described for evaluating the combination of a labeled pharmaceutical and an imaging system used for radioisotope scanning in cylindrical and spherical phantoms. The pharmaceuticals included EDTA, iron complexes, iron aggregates, and Zr colloids labeled with ^{68}Ga; albumin macroaggregates, iron complexes, sodium technetates, and sulfur colloids labeled with ^{99}Tc; and EDTA, iron complexes, Zr aggregates, and Zr colloids labeled with ^{113}In. The scanning systems included a collimated gamma camera, a 3-in., and a 5-in. scintillation scanner. Results are included from measurements of the radiation dose to the organ visualized and to critical organs when ^{68}Ga, ^{113}In, or ^{99}Tc was used to visualize lesions of the brain, kidney, liver, or lung. The phantom measurements took into account the effects of isotope distribution and absorption and scattering in the surrounding tissues. Results showed that ^{99}Tc gave best results, while ^{68}Ga was of limited value as a scanning agent, and ^{113}In performed better with the 5-in. than with the 3-in. scanner. (C.H.)

6489 (COO-1422-24) TRANSMISSION SCANNING WITH ^{99m}Tc AND ^{137}Cs. Sorenson, James A.; Briggs, Russell C. (Wisconsin Univ., Madison, Dept. of Radiology). July 22, 1968. Contract AT(11-1)-1422. 3p. (CONF-681201-1). Dep. CFSTI.

For Presentation at Annual Meeting of the Radiological Society of America, Chicago, Ill.

Methods are described for making transmission images of the human chest using ^{99}Tc or ^{137}Cs as the radiation source. A rectilinear scanner was used. Good transmission scans were obtained with a 10 mCi ^{99}Tc source but the 6 hr half-life of ^{99}Tc requires that a new source must be prepared each day. The high energy of a ^{137}Cs source resulted in poor contrast between bone, water, and air space. (C.H.)

6490 (NSJ-tr-96) γ-LABELLING WITH ^{85}Sr FOR IN VIVO MEASUREMENT OF ^{90}Sr. AN ATTEMPT FOR THE IN VIVO MEASUREMENT OF ^{90}Sr AND ^{90}Y IN INTERNALLY EXPOSED ANIMALS. Matsuoka, Osamu; Tanaka, Eiichi; Eto, Hideo.

Translated from Radioisotopes (Tokyo), 15: 261-8(Sept. 1966). 18p. Dep. JCL $1.60 fs, $0.80 mf.

A γ labeling method was developed to determine the amount of ^{90}Sr in vivo. A mixture of ^{90}Sr and small amounts (2 to 5% in activity) of ^{85}Sr was administered to the animal, and the γ rays of 0.513 MeV from ^{85}Sr were measured with a scintillation counter. The counting efficiency was determined beforehand with the original mixture solution. Activity from ^{90}Y existing with ^{90}Sr was measured by its bremsstrahlung effect. This method was applied to the study of internal exposure from ^{90}Sr and the whole-body retention of ^{90}Sr. An example of the results obtained with mice is shown. (auth)

6491 (NYO-910-76(App.1)) METHODS AND APPLICATIONS OF QUANTITATIVE COMPUTER-ANALYZED SCANNING. Appendix I. Laughlin, J. S.; Kenny, P. J.; Weber, D. A.; Dwyer, A. J.; Mayer, K.; Greenberg, E. J.; Dimich, A. B.; Hasan, S. (Sloan-Kettering Inst. for Cancer Research, New York). [1968]. Contract AT(30-1)-910. 31p. (CONF-680804-6). Dep. CFSTI.

From Symposium on Medical Radioisotope Scintigraphy, Salzburg, Austria.

A program of metabolic studies was carried out with quantitative procedures during the past decade with a variety of radioisotopes and labeled compounds. These studies demonstrated the capabilities of labeled pharmaceuticals, not only for kinetic studies, but also for diagnostic and localization purposes. Data display options included digital scans, computer-analyzed scans, and photoscans. The radioisotopes used included ^{198}Au colloids, ^{18}F, ^{52}Fe and ^{59}Fe as ferrous citrate, ^{99}Tc as sulfur colloid, ^{99}Tc pertechnetate, and ^{85}Sr. Seven features of the quantitative scanning method are illustrated with both research and diagnostic examples. (auth)

6492 RADIOACTIVE ^{18}F PHOTOSCANNING. A DIAGNOSTIC EVALUATION IN CARCINOMA OF THE PROSTATE. Williams, Donald F.; Blahd, William H.; Wetterau, Leonard Jr. (Univ. of California School of Medicine, Los Angeles. Wadsworth Hospital, Los Angeles). J. Urol., 100: 675-9(Nov. 1968).

A new, positron-emitting isotope of fluorine, ^{18}F, was investigated for use in scanning bones. The ^{18}F photoscan was found to be a sensitive means of detecting metastatic disease. The ^{18}F photoscan was technically better than the ^{85}Sr scan and also much easier to read. Fluorine-18 has a physical half-life of 1.87 hours in contrast to the 65-day half-life of ^{85}Sr. This short half-life time permits the administration of large tracer doses with little radiation exposure to the patient. Scanning can be repeated as often as desired without interference from the previous dose. Fluorine-18 accumulates in bone 10 times more rapidly and more selectively than calcium or strontium. The radioisotope of choice in skeletal system photoscanning is ^{18}F. It is invaluable as a preoperative adjunct in the over-all evaluation of patients with adenocarcinoma of the prostate who are potentially curable candidates by total, radical prostatectomy. It is also a useful tool in the management of patients with known metastatic disease, particularly when radiotherapy is contemplated. (auth) (TSS)

6493 THE PATHOLOGIC BASIS OF THE STRONTIUM BONE SCAN. STUDIES FOLLOWING ADMINISTRATION OF Sr CHLORIDE ^{85}Sr AND Sr NITRATE ^{85}Sr. Charkes, N. David; Young, Irving; Sklaroff, David M. (Albert Einstein Medical Center, Philadelphia). J. Amer. Med. Ass., 206: 2482-8(Dec. 9, 1968).

Bone biopsy specimens were obtained from 30 cancer patients who were scanned following injection of strontium chloride or strontium nitrate; autopsies were done in four additional patients. In 15 cases the ^{85}Sr concentration of the specimens was determined. Deposits of ^{85}Sr in actively proliferating new bone formed in reaction to tumor invasion. If ^{85}Sr as strontium chloride or strontium nitrate is injected when the reactive process is completed, the scan is normal although the roentgenogram may be dense. Lesions that are radiolucent but scan-normal show no evidence of reactive bone formation. The scan depicts the activity of the reactive process, whereas the roentgenogram shows the net changes that have occurred, both destructive (radiolucencies) and reparative (radiodensities). Tumor cells were found in bone at the site of the abnormal scan in 22 of the 28 patients (79%). (auth)

6494 PROTECTIVE EFFECTS, TOXICITY, AND MECHANISMS OF ACTION OF RADIOPROTECTIVE SUBSTANCE. Maisin, J. R. (CEN, Mol, Belgium). Bull. Acad. Roy. Med. Belg., 8: 149-82(1968). (In French).

It was demonstrated that administration of mixtures of radioprotective compounds not only increased the degree of protection of mice after thirty days compared with that for each substance given separately, but also diminished the toxicity of such compounds as AET or MEA. The most potent mixtures of radioprotectors (AET + MEA + Cyst. + GSH + 5-HT) yielded a dose reduction factor of 2.8 and more. When supplemented by treatment with isogenic bone marrow after irradiation, this dose reduction factor increased to 3.7 or more. Study of the long term effects revealed that most of the mice x irradiated with 2000 R or more, die of radiation pneumonitis within a period of six months. The protected mice irradiated with 700 R had a better survival than the mice irradiated without protection. Sulfhydryl radioprotectors given separately or in association exert a great influence on cellular metabolism: incorporation of ^{3}H-thymidine into DNA was diminished and the generation cycle of the stem cells of the crypts of the small intestine was prolonged. These modifications were more pronounced when the protective drugs were more active. (auth)

6495 VENTILATION-PERFUSION RELATIONSHIP IN HUMANS MEASURED BY SCINTILLATION SCANNING. Marks, Asher; Chervony, Isaac; Lankford, Robert; Smith, Edward M.; Gilson, Albert J.; Smoak, William (Univ. of Miami, Fla.). J. Nucl. Med., 9: 450-6(Aug. 1968).

A method for determining regional pulmonary ventilation-perfusion relationships during the steady state by quantitative scintillation scanning using a 10-crystal rectilinear scanner is described. Regional air distribution was measured by the rates of washin and washout of ^{133}Xe and perfusion was determined immediately thereafter using ^{131}I-labeled macroaggregated human albumin. Data are accumulated and recorded on magnetic tape for computer analysis to obtain numerical presentation. The method has proven valuable in the assessment of regional pulmonary function in normal subjects and patients with a variety of pulmonary diseases. (auth)

6496 OPTIMIZATION OF TIMING AND POSITIONING OF THE TECHNETIUM BRAIN SCAN. Miller, Marshall S.; Simmons, Guy H. (Univ. of Cincinnati). J. Nucl. Med., 9: 429-35(Aug. 1968).

Kinetic studies were performed with a γ camera following intravenous injection of ^{99}Tc-pertechnetate in 20 essentially normal individuals. Counting rates over the brain followed a consistent pattern which is described and compared with the decline in blood counts. At 30 min the observed brain counting rate was 89% of the plateau level and was falling at a single exponential rate with a half-time of 160 min. The ratio of counts recorded over the brain to counts in peripheral blood rose to a maximum 30 to 60 min after injection. This change in ratio and the observation that some neoplasms are not distinguishable before 30 min make it reasonable to insist on a waiting period of at least 30 min before examining the injected patient. In patients with suspected blood vessel malformations early views (0 to 5 min) are of value because late photos may not show the lesion. Spuriously positive scintiphotographs are easily obtained by imperfect positioning, largely because of the accentuation of superficial activity. Recommendations for routine and special views are given. (auth)

6497 PRACTICAL INFERENCES FROM STUDIES WITH A "BREATHING" LIVER PHANTOM. Stewart, Howard R. (Methodist Hospital, Lubbock, Tex.); Best, Edward B. Amer. J. Roentgenol., Radium Ther. Nucl. Med., 104: 686-91(Nov. 1968).

A simple and inexpensive liver phantom capable of simulating respiratory motion was constructed from materials readily available in most radioisotope laboratories and radiology departments. The effects of motion on liver scanning were studied simulating conditions in the adult human as closely as possible in regards to technical and physical factors as well as the type of radionuclide and dosage used. These studies showed that the indentations (picket fence effect) noted at the margins of the liver are caused by the combined effects of respiratory movement of the liver and rectilinear movement of the conventional scanner; that counting rates and thereby the efficiency of the detector are affected by this motion; and that the smallest nodule detectable in a motionless phantom will not be seen at all when a motion similar to human diaphragmatic excursion is added. (auth)

6498 REDUCTION OF RESPIRATORY ARTIFACT IN SCINTILLATION SCANNING. Atkins, H. L.; Hauser, W.; Richards, P. (Brookhaven National Lab., Upton, N. Y.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 104: 682-5(Nov. 1968).

Optimum utilization of high-flux scanning of the liver with short half-lived radionuclides can be obtained with reduction in respiratory artifact. This is achieved through the use of data blending or of multiple overlapping during photorecording, utilizing small increments of line spacing. Results obtained using a phantom filled with ^{99}Tc solution are reported. (auth) (TSS)

6499 SPLEEN IRRADIATION IN SECONDARY HYPERSPLENISM. Comas, F. V.; Andrews, G. A.; Nelson, B. (Oak Ridge Associated Universities, Inc., Tenn.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 104: 668-73(Nov. 1968).

The effect of splenic irradiation on the hematologic manifesta-

tions of hypersplenism (hemolytic anemia, granulocytopenia, and thrombocytopenia) was studied. Eight patients with hypersplenism secondary to various diseases had their spleens irradiated with doses of between 700 and 2,000 R γ in a period of 8 to 17 days. Although most of the patients had some clinical improvement, related particularly to the reduction in spleen size, the hypersplenic manifestations showed little response to the treatment. Only one patient had a lasting remission of hemolytic anemia, and even this was not clearly attributable to splenic irradiation. Splenectomy was effective in controlling hypersplenism, and, when feasible, is the treatment of choice for this condition. (auth)

6500 THE PREPARATION OF ^{99m}Tc LABELED CYSTINE, METHIONINE, AND A SYNTHETIC POLYPEPTIDE AND THEIR DISTRIBUTION IN MICE. Tubis, Manuel; Endow, John S. (Veterans Administration Center, Los Angeles. Univ. of California School of Medicine, Los Angeles). Int. J. Appl. Radiat. Isotop., 19: 835-40(Dec. 1968).

Methods are presented for the labeling with ^{99m}Tc of the pancreatotrophic amino acids cystine and methionine and a synthetic heptacosapeptide amide hormone with secretin-like properties. The distribution of these compounds in the organs of mice is described, with implications for the use of these compounds and their analogs as potential scanning agents for the pancreas and other organs. Further studies are in progress with a view to use of these compounds for scanning the human pancreas for abnormalities of function and structure. (INIS) (UK)

6501 METHOD FOR THE QUANTITATIVE EVALUATION OF RADIOISOTOPE RENOGRAMS. Heiskanen, Timo; Weber, Theodor; Graesbeck, Ralph (Maria Hospital, Helsinki). Int. J. Appl. Radiat. Isotop., 19: 827-34(Dec. 1968).

A mathematical model for renography is presented. The model is based solely upon physiological quantities. With the aid of this model the following information can be deduced: (1) The individual clearance of the kidneys expressed in percent of total clearance. (2) An estimate of the ratio of the urinary flow to the volume of the renal pelvis. This quantity is obtained by comparing the measured renogram with simulated renograms in which the urinary flow and the volume of the renal pelvis are known. In addition the measurement procedure gives the ordinary renogram and a blood clearance curve. The solutions of the differential-difference equations involved are presented. Oscillations (waves or steps) in the excretory phase, often observed in measured renograms, were predicted by the mathematical treatment and must be regarded as normal phenomena. (INIS) (UK)

6502 RADIOACTIVE NUCLIDES IN MEDICINE AND BIOLOGY. THIRD EDITION. Silver, Solomon (ed.). Philadelphia, Lea and Febiger, 1968. 552p. $12,50.

Medical uses of radionuclides are dealt with in this volume intended as a reference and text for physicians. The use of radioactive iodine in diagnosis and treatment of thyroid conditions is given intensive coverage. Radiotherapy of leukemia and other blood diseases and lymphomas with ^{32}P and colloidal ^{198}Au is considered. Other diagnostic and physiologic studies using radioisotopes are detailed. An index is provided and a bibliography is given with each section of the book. (CO)

6503 DIAGNOSIS OF NORMAL-PRESSURE HYDROCEPHALUS BY RISA CISTERNOGRAPHY. Patten, David H.; Benson, D. Frank (Boston Veterans Administration Hospital). J. Nucl. Med., 9: 457-61(Aug. 1968).

The use of intrathecal ^{131}I (RISA) scanning for demonstrating normal-pressure hydrocephalus, a condition exhibiting obstruction of flow through the cortical subarachnoid space preventing normal cerebrospinal fluid absorption, is described. The technique is simple, with introduction of RISA by spinal tap followed by sequential scanning over the next 2 or 3 days. A positive diagnois is made by demonstrating enlarged ventricles and lack of radioactivity in the sagittal region. Because normal-pressure hydrocephalus can be treated successfully by ventriculovenous shunting, this technique offers considerable value. (auth)

6504 SIGNIFICANCE OF RADIOISOTOPES IN MEDICAL RESEARCH. Vetter, H. (International Atomic Energy Agency, Vienna). Therapiewoche, 17: 2056-9(Dec. 13, 1967). (In German).

The use of radioisotopes in clinical research is discussed with some illustrative examples, such as determination of insulin concentration in the blood by means of saturation analysis, determination of serum concentration of a steroid by derivative analysis, calculation of albumin synthesis, measurement of albumin incorporation or loss, and determination of ^{64}Cu distribution in the body. (J.S.R.)

6505 APPLICATIONS OF A NUCLEAR REACTOR IN CLINICAL RESEARCH AND PRACTICE. Scheer, K. E. (Krebsforschungszentrum, Heidelberg). Therapiewoche, 17: 2060-2 (Dec. 13, 1967). (In German).

The clinical uses of reactors as sources of high neutron densities are briefly summarized, with emphasis on the detection of trace elements by neutron activation. The detection sensitivities of 30 elements are tabulated. The use of stable isotopes in indicator studies is also considered. (J.S.R.)

6506 RADIOISOTOPES IN CLINICAL FUNCTION DIAGNOSIS. zum Winkel, K. (Univ., Heidelberg). Therapiewoche, 17: 2063-7(Dec. 13, 1967). (In German).

The methods for clinical diagnosis of function can be divided into three groups: methods of continuous radioactivity measurement under the same measurement geometry, scanning methods for the representation of incorporated radioactivity, and scintigraphic methods for the representation of incorporated radioactivity with fixed detectors. Examples are given of each of these types of diagnosis. (J.S.R.)

6507 USE OF RADIOISOTOPES FOR LOCALIZED TREATMENTS. Gauwerky, F. (Institut fuer Strahlentherapie und Nuklearmedizin, Hamburg). Therapiewoche, 17: 2067-71(Dec. 13, 1967). (In German).

The properties of the radioisotopes most frequently used for localized treatment (^{60}Co, ^{137}Cs, ^{192}Ir, ^{182}Ta, and ^{198}Au) are discussed. Examples are given of the use of radioisotopes externally in the form of moulages, inserted in body cavities, implanted as needles or seeds in tumors, and in treatment of basilomas of the conjuctiva. (J.S.R.)

6508 RADIOACTIVE XENON IN THE DIFFERENTIAL DIAGNOSIS OF PULMONARY EMBOLISM. Wagner, Henry N. Jr.; Lopez-Majano, Vincent; Langan, James K.; Joshi, Ramesh C. (Johns Hopkins Medical Institutions, Baltimore. Veterans Administration Hospital, Baltimore). Radiology, 91: 1168-74 (Dec. 1968).

A simplified method is described that uses ^{133}Xe to aid in the differential diagnosis of acute pulmonary embolism from other diseases of the lung that cause decreases in pulmonary arterial blood flow. Using two stationary crystal scintillation detectors, the equilibration half-time of the radioactive gas during quiet breathing was measured in a closed spirometer system. The detectors were positioned according to the location of the lesions as determined by lung scans and chest radiographs. The validity of the method was established by comparing the relative ventilation of the two lungs as measured with ^{133}Xe with the ventilation measured directly by bronchospirometry. The equilibration half-time in the region of the lesions was essentially normal (less than thirty seconds) in patients with pulmonary embolism alone, but impaired (greater than thirty seconds) in patients with focal obstruction of bronchi. (auth)

6509 ORIGIN AND EVOLUTION OF RADIOACTIVE PULMONARY EMBOLI IN MAN. Duffy, George J.; DeNardo, Gerald L.; Abington, Robert B. (Veterans Administration Hospital, Stanford, Calif. Stanford Univ., Calif.). Radiology, 91: 1175-80(Dec. 1968).

Two cases are reported in which difficulties with the administration of ^{131}I-MAA resulted in the production of immediate and delayed types of radioactive pulmonary emboli and to artefactitiously abnormal lung scans. The biological half-lives of the immediate radioactive pulmonary emboli varied from three to five and one-half days, whereas the half-lives of the delayed and organizing emboli varied from ten and one-half to twenty-three days. In one case, an organized radioactive embolus was identified at autopsy. In vitro experiments revealed consistently greater radioactivity per gram of ^{131}I-MAA-blood admixture than per gram of ^{131}I-MAA fluid alone. This may explain the mechanism of production of the radioactive emboli. (auth)

6510 FATALITY IMMEDIATELY FOLLOWING RAPID INFUSION OF MACROAGGREGATES OF ^{99m}Tc ALBUMIN (MAA) FOR LUNG SCAN. Vincent, William R.; Goldberg, Stanley J.; Desilets, Donald (Univ. of California, Los Angeles). Radiology, 91: 1181-4; 1180(Dec. 1968).

The second patient reaction known to date following infusion of macroaggregates of albumin for lung scan is described. This represents the first known fatality in over 50,000 patient scans and occurred almost immediately following an intravenous injection of MAA. In temporal relationship the reaction was similar to the hemodynamic reaction of experimental MAA toxicity in dogs. The patient had severe pulmonary vascular disease that would explain MAA particle occlusion of a greater proportion of the vascular bed than in the case with the usual scanning dose. In addition, a decreased distensibility prevented a vascular adaptation that would allow the continuation of an adequate level of flow in the remaining vessels. It was suggested that this type of reaction would continue to be rare and that it would probably be somewhat pre-

dictable on the basis of clinical and laboratory evidence of severe pulmonary hypertension. Such a patient might be scanned safely by strict control of MAA dose, size range, and mean particle size. (auth)

6511 RADIONUCLIDE DIAGNOSIS OF ARTERIOVENOUS MALFORMATIONS WITH RAPID SEQUENCE BRAIN SCANS. Rosenthall, Leonard (Montreal General Hospital). Radiology, 91: 1185-8(Dec. 1968).

Arteriovenous malformations of the brain are visualized predominantly by virtue of their blood pool rather than by diffusion of a radiopharmaceutical across an altered blood-brain barrier. On a conventional scan their appearance is nonspecific. Arteriovenous malformations, however, offer a low resistance to blood flow, which results in a considerable shunting of cranial blood through the lesion. This can be observed with serial five-second-exposure scintiphotos following an antecubital vein injection of ^{99}Tc-pertechnetate. The hallmark of this condition is a higher concentration of radioactivity in the lesion with the initial entry of the bolus over five-second intervals than in a two- or three-minute conventional scan obtained soon after the injection. (auth)

6512 DIAGNOSIS OF ARTERIOVENOUS FISTULA OF THE KIDNEY WITH RENAL BLOOD FLOW SCINTIPHOTOGRAPHY. Freeman, Leonard M.; Meng, Chien-hsing; Blaufox, M. Donald (Albert Einstein Coll. of Medicine, Bronx, N. Y. Bronx Municipal Hospital Center, N. Y.). Radiology, 91: 1189-90; 1188(Dec. 1968).

Isotopic visualization of renal blood flow using ^{197}Hg-chlormerodrin or ^{99}Tc-pertechnetate and the Anger camera was used for the diagnosis of arteriovenous fistula of the kidney. It is suggested that radioisotope scanning, combined with intravenous urography, may serve as a useful screening method after biopsy. (C.H.)

6513 DETERMINATION OF LIVER MASS FROM RADIONUCLIDE IMAGES. Rollo, Frank D.; DeLand, Frank H. (Johns Hopkins Medical Institutions, Baltimore). Radiology, 91: 1191-4(Dec. 1968).

A method of determining the mass of the liver from colloidal ^{198}Au, colloidal ^{99}Tc-pertechnetate images was applied to 21 sets of photoscans. Measurements of liver mass were made by three individuals independently. The results were combined to determine the mean and relative error for each case. The relative errors were all less than 8 percent with a mean of ±3.8 percent, indicating the method to be reproducible. The liver masses were available in 15 cases (postmortem examination). The differences between measurement of the liver masses by this method and that obtained from the autopsy protocols varied from 0.5 to 7.6 percent (mean error = ±3.6 percent). (auth)

6514 ^{169}Yb DIETHYLENETRIAMINEPENTAACETIC ACID COMPLEX. A NEW RADIOPHARMACEUTICAL FOR BRAIN SCANNING. Hosain, Fazle; Reba, Richard C.; Wagner, Henry N. Jr. (Johns Hopkins Medical Institutions, Baltimore). Radiology, 91: 1199-1203; 1194(Dec. 1968).

Ytterbium-169 is a γ-emitting isotope with a 32-day physical half-life; the photons between 160 and 220 keV are suitable for brain scanning. Ytterbium-169 was chelated with diethylenetriaminepentaacetic acid. Ninety-nine percent of the intravenously injected dose of the complex in mice was excreted rapidly within one day; the remaining 1 percent was eliminated at a slower rate. In black mice with experimental ependymomas, the ratio of the concentrations of ^{169}Yb-DTPA complex in the tumor compared to brain was greater than 20 : 1 shortly after intravenous injection. The agent was not toxic, and the radiation dose was comparable to that of other agents. After initial experiments in animals, preliminary trials of its use as a brain-scanning agent were begun. Images comparable to $^{99m}TcO_4^-$ were obtained in patients with brain tumors. This new agent, which has a long shelf-life and short biological half-life, may replace ^{203}Hg-chlormerodrin as a brain-scanning agent. (auth)

6515 INTRAVENOUS RADIOISOTOPE ANGIOGRAPHY USING ^{113m}InFeDTPA-ASCORBIC ACID. Hisada, Kin-ichi; Mishima, Tsutomu; Hiraki, Tatsunosuke; Tonami, Norihisa; Matsudaira, Masamichi; Kuranishi, Makoto (Kanazawa Univ., Japan). Radiology, 91: 1204-7; 1213(Dec. 1968).

Radioisotope angiography was successfully performed with the scintillation camera and a large dose of ^{113m}InFeDTPA-ascorbic acid. The biological behavior of ^{113m}InFeDTPA-ascorbic acid is the same as that of ^{113m}InFeDTPA, but the former can be easily sterilized through a millipore filter and injected as a neutral solution without $Fe(OH)_3$ precipitation. Some preliminary results are illustrated. Renal cysts and neoplasms were easily distinguished by this method. It is suggested that the words vascular phase and functional phase be used in the reading of radioisotope renal angiograms. The ^{113m}In generator has many advantages over the ^{99m}Tc generator and the radioisotope angiograms obtained were never poor in quality of image. (auth)

6516 EVALUATION OF REGIONAL PULMONARY VENTILATION BY GAMMA RAY DENSIGRAPHY. Zelefsky, Melvin M.; Schulz, Robert J. (Albert Einstein Coll. of Medicine, Bronx, N. Y.). Radiology, 91: 1208-13(Dec. 1968).

The measurement of pulmonary radiodensity variations during respiration has been shown to be a reliable index of regional pulmonary ventilation. Widespread use of this method may have been hampered by technical problems. A relatively simple apparatus was described that overcame these technical difficulties. This apparatus consisted of a scintillation detector mounted on a U-shaped yoke in alignment with an ^{241}Am γ-source. Details of the performance of the examination as well as the physical background of the technic are described. (auth)

6517 RADIATION HEPATITIS: POSSIBLE PREVENTION BY COMBINED ISOTOPIC AND EXTERNAL RADIATION THERAPY. Kaplan, Henry S.; Bagshaw, Malcolm A. (Stanford Univ., Palo Alto, Calif.). Radiology, 91: 1214-20(Dec. 1968).

The pathology of radiation injuries of the liver is reviewed. A method is described for the treatment of Hodgkin's disease involving the liver and abdominal lymph nodes using combined external x radiation and internal hepatic irradiation following the intravenous administration of ^{198}Au colloid. The method resulted in radiation injury to the liver in a limited number of cases. (C.H.)

6518 DIFFERENTIAL HYPOTHERMIA-NORMOTHERMIA AS A NEW TOOL TO ENHANCE THE ACTIVITY OF ANTI-CANCER DRUGS. RADIOISOTOPE STUDY. Masironi, R.; Popovic, Vojin P. (Emory Univ., Atlanta). Acta Isotop., 7: 289-98(Dec. 30, 1967).

When the body of a tumor-bearing animal was cooled to 15°C while the tumor was maintained at normothermic level (37°) the effectiveness of an anti-cancer drug was enhanced. A small, nontoxic dose (50 mg/kg) of 5-fluorouracil injected intravenously under these conditions acquired the same effectiveness of a 200 mg/kg dose. On normothermic tumor-bearing animals, instead, the former dose would be ineffective and the latter would be effective but also lethal. The advantages of increasing effectiveness without increasing toxicity are obvious. The technique of differential hypothermia-normothermia could also be applied to radiobiological cancer study. The tumoricidal action of radiations could be possibly enhanced; radiosensitizers and radioactive substances could be preferentially accumulated into tumors and thus deliver their actions in loco. (auth)

6519 LIVER SCAN IN CIRRHOSIS. Ziliotto, D.; Vianello, A.; Ferlin, G. (Univ., Padua). Acta Isotop., 7: 355-75(Dec. 30, 1967). (In Italian).

A colloidal gold ^{198}Au scintiscan was carried out in 85 patients with cirrhosis of the liver. In each case an abnormal picture was obtained. The most frequent alterations observed were: size changes (87% of cases), shape variations (82.3%), structure abnormalities (76.4%), spleen visualization of variable degree (91.7%) often accompanied by spleen enlargement, and the presence of bone marrow uptake (55.3%). None of these findings were constant and none of them could be considered as pathognomonic. However, the concomitant presence of some or of all these elements could often give the picture a characteristic image consistent with the diagnosis of cirrhosis. (auth)

6520 REORGANIZING DATA FROM TRANSVERSE SECTION SCANS OF THE BRAIN USING DIGITAL PROCESSING. Kuhl, David E.; Edwards, Roy Q. (Univ. of Pennsylvania, Philadelphia). Contract AT(30-1)-3175. Radiology, 91: 975-83(Nov. 1968). (NYO-3175-35).

Transverse section scanning is used to portray radioactivity in the brain as a cross-section picture. In the original report of the technic, film exposure summation, that is 24 separate exposures of film, was used to integrate the scan data into a section picture. In this report, digital summation is introduced as an improvement of the method. With digital summation the original scan data are transferred from perforated paper tape to a magnetic storage drum and then automatic operation controlled by a program tape is used. After processing, the transverse section picture is represented as a square matrix of 10,000 picture elements, each of which represents the average of counts detected over that location at a detector positioned on the nearest side (single-sector addition) or, alternatively, by detector positions on both sides (double-sector addition), for all 24 tangent scans. It was concluded that digital summation of transverse section data is more useful than film exposure summation because the method is more easily learned by relatively unskilled technicians, picture quality is more objectively controlled, results

are more reliable and reproducible, and the rectilinear format is compatible with other rectilinear processing modes. (auth)

6521 "HOT" RENAL TUMOR. SCANNING AND ANGIOGRAPHIC CHARACTERISTICS OF A SOLID RENAL TUBULAR ADENOMA. Caplan, Gerald E.; Hartmann, H. Rodney; Young, Reynolds; Victor, Irving (Memorial Medical Center, Savannah). Radiology, 91: 991-2(Nov. 1968).

A case of a renal tubular adenoma diagnosed preoperatively on the basis of unique findings on a renal scan and renal arteriogram is presented. It is suggested that the presence of a hot spot on a chlormerodrin ^{203}Hg renal scan is diagnostic of a renal tubular adenoma. Arteriographic findings included absence of abnormal vascularity and the rapid appearance of a dense and persistent nephrogram in the tumor itself; this angiographic pattern may also be characteristic of a tubular adenoma, and when it is encountered a renal scan should be performed. (auth)

6522 SCINTIGRAPHIC AND ANGIOGRAPHIC EXPLORATION OF THE PANCREAS IN A CASE OF INSULINOMA: PRESENTATION OF A NEW SCINTIGRAPHIC TECHNIQUE. Austoni, M.; Cevese, P. G.; Trisotto, A.; Federspil, G.; Macri, C. (Univ., Padua). Acta Isotop., 7: 253-60(Dec. 30, 1967).

A new technique for scintigraphic study of the pancreas was proposed. The procedure was based on the injection of ^{131}I-labeled albumin macroaggregates into the celiac trunk and the superior mesenteric artery. The results obtained by the use of this technique combined with a selective angiography in a case of insulinoma are presented. (auth)

6523 ^{99m}Tc LABELLED TOLUIDINE BLUE O FOR LIVER SCINTILLOGRAPHY. Yeh, S. H.; Delahay, J. E.; Kriss, J. P. (Stanford Univ., Palo Alto, Calif.). Int. J. Appl. Radiat. Isotop., 19: 885-7(Dec. 1968).

Since the observation of the preferential concentration of toluidine blue O (TBO) in the parathyroid gland and pancreas, it has been suggested that radioisotopic "labelling" of this dye might permit visualization of these organs by scanning procedures. In view of its ideal physical characteristics for scintillography, technetium-99m would be a suitable isotope for tagging the dye. The preparation, tissue distribution and scintillography of ^{99m}Tc–TBO aggregates are described. (INIS) (UK)

6524 SOME BIOCHEMICAL PECULIARITIES OF THE COMBINED ACTION OF ULTRAVIOLET RAYS AND X RAYS ON AN ORGANISM. Baraboi, V. A.; Zagoruiko, L. I.; Ostrits'ka, L. M.; Fialek, V. U. (Inst. of Physiology, Kiev). Fiziol. Zh., Akad. Nauk Ukr. RSR, 14: 504-13(July-Aug. 1968). (In Ukrainian).

Changes in glucose content, blood cholinesterase activity, and the urinary excretion of 17-oxycorticosteroids of guinea pig were studied in order to determine the preventive effects of uv irradiation on the lethal effects of x rays. It was established that the repeated use of uv rays affected the reaction of a mammalian organism in such a way that a more quiet, slower, and less manifested reaction to the x-ray lethal dose was observed. This slower reaction is noted in the form of hyperglycemia, a cholinesterase activity decrease, and an excretion of corticosteroids. (IAA)

6525 HISTORICAL REVIEW OF THE BETATRON AS A SOURCE OF ELECTRONS. Kerst, D. W. (Univ. of Wisconsin, Madison). pp 1-6 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

Investigations were undertaken to provide more knowledge of the physical characteristics of high-energy electrons from the Siemens 18 MeV betatron used in tumor therapy. Basic calibrations of dose and energy, dose distribution measurements, and tissue heterogeneity studies were made. It was found that ferrous sulfate could be used as a basic measuring system for an electron beam treatment facility, using the established G values. Inhomogeneities had a marked effect on dose distribution. The thickness of the chest wall was determined in order to properly adjust the beam energy to spare the underlying pulmonary parenchyma during chest irradiation. Simple formulae allowed corrections for attenuation of the beam by bone of the density of the bone involved was known. Lithium fluoride, film measurement, and ion chambers all had appropriate roles in electron beam dosimetry. Each was correlated with a system of absolute measurement, and the limitations of each thoroughly understood. (M.M.B.)

6526 ELECTRON BEAM THERAPY. Proceeding of the Second Annual San Francisco Cancer Symposium, 1968. Vaeth, Jerome M. (ed.). Frontiers of Radiation Therapy and Oncology. Volume 2. Basel, S. Karger AG, 1968. 273p. DM 73.–; $17.50; 146s. (CONF-661065).

The use of electrons for radiation therapy of cancer is explored. Authorities in radiation physics, radiobiology, and radiation therapy contributed with their recent experience in this field. Current RBE data, radiation physics and dosimetry, and clinical radiotherapeutic techniques and results are presented; the text is accompanied by numerous illustrations. Separate abstracts were prepared for all 21 papers. (M.M.B.)

For abstracts of individual papers see: 6470–6472, 6525, and 6528–6544.

6527 RADIATION ABORTION IN RADIOTHERAPY. Bowerman, Jack W.; El-Mahdi, Anas M.; Lott, James Stewart; Julian, Conrad G. (Johns Hopkins Hospital, Baltimore). Radiology, 91: 1013-16(Nov. 1968).

Two cases of intrauterine pregnancy combined with pelvic or lower abdominal malignant growth are presented, and the different abortion responses are discussed in relation to the gestation times and the different forms of radiotherapy employed. Abortion may occur as late as seven weeks after the institution of a course of 2,850 rads midplane pelvic γ-dose delivered in four weeks with a telecobalt unit to a patient with a sixteen-week pregnancy. Abortion may not occur at all and in fact did not take place during or after a treatment that delivered an estimated dosage of 4,850 rads in five weeks to the midportion of a fourteen-week gravid uterus. Serial urinary estriol and chorionic gonadotropin assays are suggested as a means of relating fetal and placental responses to irradiation. (auth)

6528 A 10 TO 25 MeV ELECTRON BETATRON AND THE USE OF THE PLANE DENSITOMETER TO ANALYSE BEAM DISTRIBUTIONS. Lescrenier, C.; Gunn, W. G.; Benbow, R. M.; Sorensen, A. (Marquette Univ., Milwaukee). pp 78-86 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

The development of the plane densitometer has encouraged an extensive program using film for dosimetry. A library of over 1000 films is available and isodensity shapes can be reproduced within seconds for studies in retrospect. An expedient procedure is described that is repeatable and valid to evaluate individual parts such as phantom material or the film itself. The technique lends itself best for unstable beams or very sharp dose gradients inaccessible to conventional methods. Its application to a 10 to 25 MeV electron generator is described. (auth)

6529 PROBLEMS OF INHOMOGENEOUS MEDIA AND BEAM SHAPING WITH HIGH-ENERGY ELECTRONS. Schulz, R. J. (Albert Einstein Coll. of Medicine, New York). pp 67-77 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

Disregarding any differences in biological effectiveness, the single advantage of high energy electron beams is their easily controlled depth of penetration. The problems involved in dose distributions and treatment planning are very complex and may outweigh the advantages of electron beam treatment. Dose distribution and beam shaping investigations are reported. The importance of in vivo dosimetry as a basis for treatment planning is stressed. (M.M.B.)

6530 ELECTRON PENCIL BEAM SCANNING AND ITS APPLICATION IN RADIATION THERAPY. Lanzl, L. H. (Univ. of Chicago). pp 55-66 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

The underlying goal of beam scanning in therapy is to take the fullest advantage of the physical properties of electron absorption. The technique and equipment and their use for therapy are described. Differences between the conventional scatter-foil technique and scanning technique of electron-beam administration are discussed. Dose planning was carried out by computer, although in situations where large changes in body density occurred, dose distribution studies were made with phantoms. (M.M.B.)

6531 PHYSICAL ASPECTS OF WHOLE-BODY SUPERFICIAL THERAPY WITH ELECTRONS. Karzmark, C. J. (Stanford Univ., Palo Alto, Calif.). pp 36-54 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

Electrons of several MeV energies were found useful for treating superficial lesions whose extensions lie within a centimeter of the skin. Some of these lesions, e.g., mycosis fungoides, extended over substantially all of the body's surface. A number of distinct techniques were developed for such treatments. They may

be divided into those in which a horizontal patient is translated relative to a narrow rectangular radiation field and those where the standing patient is irradiated with one or more broad beams of electrons. The electron sources used included Van de Graaff generators, electron linear accelerators, and the beta emitting isotope ^{90}Sr. The rapid variation of dose with depth presented specific measurement problems. The dosimetry methods that were used for such electron beams are reviewed. Radiation safety problems occurred because of the high electron dose rate capability of accelerator electron sources as well as from the possibility of mechanical translation failure in scanning systems whose dosimetry was based on patient velocity relative to the electron source. (auth)

6532 PHYSICAL ASPECTS OF ELECTRON THERAPY WITH A 35 MeV LINEAR ACCELERATOR. Ovadia, J. (Michael Reese Hospital, Chicago). pp 25-35 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

Electrons from a linear accelerator at Michael Reese Hospital were used for therapy for more than 10 yr. The methods utilized to produce suitable beams, dose distributions that were achieved in selected treatment conditions, and the limitations of the present facility are reviewed. (M.M.B.)

6533 PHYSICAL BASIS OF HIGH ENERGY ELECTRON THERAPY. Wright, Ann; Almond, P. R.; Boone, M. L. M. (Univ. of Texas, Houston). pp 7-24 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

The early development of the betatron and its subsequent use as a source of electrons or x rays for therapy are described. (M.M.B.)

6534 HIGH-ENERGY ELECTRON TREATMENT PLANNING AND DOSIMETRY: PAST EXPERIENCE AND FUTURE DEVELOPMENTS. Laughlin, John S. (Memorial Hospital, New York). pp 87-103 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

The treatment planning and calibration procedures used for high energy electron treatment at Memorial Hospital are described. The history, physical aspects, dosimetry, biological dependence, and needed future developments of the use of betatrons for high energy electron therapy are reviewed. (M.M.B.)

6535 RETREATMENT OF PREVIOUSLY IRRADIATED CANCER UTILIZING ELECTRONS. Zuppinger, A. (Zentrales Strahleninstitut, Bern). pp 257-67 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

Some chance of cure and palliation exists for retreating cancers that recur after previous radiation treatment with electrons. The 5-yr results of the retreatment of 114 cases for which other forms of treatment were not possible are reported. The prognosis of different tumors varies greatly. Relatively good results were obtained with retreatment of skin and lip carcinomas, and with tumors of the parotid gland, epipharynx, thyroid, and breast. Certain surprising results were achieved with soft tissue sarcomas and Hodgkin's disease. Poor results were obtained with tumors of the oral cavity, mesopharynx, and hypopharynx. When these are inoperable, preoperative irradiation with subsequent surgery should be undertaken. Although retreatment with electrons is possible in some cases, correct primary treatment offers much better results. (M.M.B.)

6536 TREATMENT OF CANCER OF THE VULVA USING ELECTRONS. Oberheuser, F. (Univ. Hospital, Hamburg. Medical School, Luebeck, Ger.). pp 248-56 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

A 15 MeV betatron of the Siemens–Reiniger produces alternately fast electrons or high-voltage x rays from 3 to 16 MeV. The fast electrons are used to treat the primary tumor and pertaining lymphatic region in cancer of the vulva. High voltage x rays are used to treat cancer at other sites, e.g., the cervix. The clinical results support the view that irradiation with electrons is the best method for treatment of cancer of the vulva. (M.M.B.)

6537 FOUR YEARS EXPERIENCE WITH CANCER OF THE BLADDER TREATED WITH HIGH-SPEED ELECTRONS. Botstein, C. (Montefiore Hospital, Bronx, N. Y.). pp 238-47 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

Four and one-half years of experience with electron beam therapy of carcinomas of the bladder are described. It was concluded that irradiation from a single anterior field taking advantage of the controlled depth dose of the fast electron beam does not improve results. The lack of complications was probably the result of lower doses than used in treatments with x- or γ rays. The program was, therefore, modified in the following ways: The single field treatment was suitable only in stages A and B (tumor confined to the bladder), provided that the floor of the bladder was no deeper than 8 cm. If the depth should be greater, x-ray beam supplements of the dose were indispensable. In stout patients, rotation or multiple fields were used. Patients in stages C and D received treatment of the entire pelvis. A single field approach was used only in exceptionally thin patients. The minimum dose did not fall below 7500 rads in an eight-week period delivered in a three-times-per-week schedule. A dose of about 8000 rads was recommended in daily treatment schedules. Care was taken to ensure uniform dose distribution in depth as well as to compensate for the shielding effect of the bones. (M.M.B.)

6538 ROLE OF ELECTRON BEAM THERAPY IN THE TREATMENT OF BREAST CANCER. Chu, Florence C. H. (Memorial Hospital, New York). pp 224-37 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

A program to investigate the role of high energy electron beam therapy in the management of breast cancer was initiated at Memorial Hospital in 1955. A total of 549 patients received 1,283 separate courses of electron beam therapy for inoperable, postoperative, recurrent, or metastatic breast cancer. Electron beam therapy proved advantageous in many for the treatment of certain types of breast cancers. The techniques are usually simple to use. The treatment plan can be tailored to meet the individual's situation and needs. In particular, electrons are effective in delivering a satisfactory tumor dose without injuring the underlying normal tissues. The indications for and methods of electron beam treatment are described, and the results of treatment are presented. Based on this 11-yr study, it is concluded that high energy electron beam therapy definitely occupies an important place in the radiotherapeutic management of breast cancer. In fact, it was found that electron beam therapy has become indispensable in daily treatment of breast cancer at the Department of Radiation Therapy at Memorial-Sloan-Kettering Cancer Center. (auth)

6539 ELECTRON BEAM IN THE TREATMENT OF ORAL CAVITY AND OROPHARYNX CANCER AND IN BOOST THERAPY. Tapley, Norah Duv; Fletcher, G. H. (Univ. of Texas, Houston). pp 213-23 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

The rapid falloff in the electron beam depth dose is of particular advantage in the treatment of malignant lesions of the oral cavity and oropharynx. It is found to be of unique benefit in the following situations: In the treatment of asymmetrical, well-lateralized lesions of limited volume with a single field or with the addition of an intraoral cone for tumor dose build-up; in tonsillar area lesions with minimal soft palate or tongue extension as combined treatment in a 1:1 or 1:2 ratio with high energy photon radiation when a greater depth dose is required, when a severe skin reaction is anticipated, or when interposed bone may decrease the depth dose; in lesions arising in the base of the tongue or in extensive lesions with base of tongue involvement as boost treatment using the submental approach. (auth)

6540 ELECTRON BEAM THERAPY AS A METHOD OF TREATMENT OF NASOPHARYNGEAL CARCINOMA. Ho, J. H. C.; Lam, C. M.; Mauldon, G. F. (Queen Elizabeth Hospital, Kowloon, Hong Kong). pp 183-12 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

The influence of clinical aspect on the planning of radiotherapy of nasopharyngeal carcinoma was discussed. The irradiated volume contains soft tissue, bone, and air cavities and also a part of the central nervous system that is unable to tolerate a high dose of radiation. The heterogeneity of the irradiated medium presents problems in dosimetry and the inevitable inclusion of a part of the central nervous system and the eyes present technical problems. Electron dosimetry was undertaken in both perspex and

human head phantoms for electron energies in the range between 10 and 35 MeV using photographic techniques. Heterogeneities were introduced into the perspex phantom to simulate air and bone inclusions within the human body. The dosimetric effect of electron scatter, focusing and absorption in heterogeneous media and typical treatment distributions of electron dose obtained within human head phantoms are presented. Taking into consideration the clinical and anatomical factors a technique for electron beam therapy of nasopharyngeal carcinoma is described. It is felt, however, that the method of choice is one that employs high energy photons to treat the primary tumor region and high energy electrons the lower part of the retrostyloid compartment of the parapharyngeal space and the cervical lymph nodes. (auth)

6541 OBSERVATIONS ON THE ELECTRON BEAM THERAPY OF MYCOSIS FUNGOIDES. Bagshaw, M. A.; Eltringham, J. R. (Stanford Univ., Palo Alto, Calif.). pp 163-82 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

Observations on the natural history and response to electron beam therapy in 61 patients with mycosis fungoides are reported. The systematic effects of electron beam therapy were negligible, however interesting side effects such as onchoptosis, painful interphalangeal joints, cutaneous edema, formation of giant bullae, and gynecomastia were observed. Although the protean nature of mycosis fungoides makes critical analysis of survival after therapy difficult, the longest survival was found in patients with minimal disease treated aggressively with doses between 1000 and 2400 rads delivered to the total skin. In order to select an appropriate electron energy for the particular variation in clinical manifestation of mycosis fungoides, the ability to vary the electron energy from between 2 and 6 MeV appears desirable. Similarly, for patients with the oncotic form of mycosis fungoides, split course therapy may be advantageous. In lieu of a variable electron beam, low kilovoltage boost therapy in intertriginous zones or to unusually thick lesions is indicated. For the most efficacious treatment of this disease the therapist must not be wedded exclusively to a particular modality. Relatively small field, low kilovoltage x-ray therapy may be used as a supplement for the treatment of small recurrent lesions. Similarly, fluocinolone acetonide or topical nitrogen mustard may induce remissions in patients whose skin tolerance to electron beam therapy is becoming exhausted. (auth)

6542 REACTIONS OF NORMAL TISSUES IN ELECTRON THERAPY. Ward, H. W. C. (St. Bartholomew's Hospital, London). pp 154-62 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

The characteristic features of an electron beam and its dose distribution are discussed. It appears that dose for dose, electrons produce much the same reactions in normal tissues as do x rays. The advantages and disadvantages of electron therapy depend on the characteristic spatial distribution of dosage that it produces. (M.M.B.)

6543 CORRELATION OF BASIC AND CLINICAL DATA. Dutreix, J. (Institut Gustave-Roussy, Villejuif, France). pp 140-53 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

The problem of correlating basic data and clinical data is discussed using as an example a clinical trial. The purpose of this trial was to investigate any difference in the regression of tumors of the tonsil during irradiation by high energy x rays or electrons. It was planned to give the same tumor dose per fraction (250 rads), three times a week. After treating 50 patients, a significant difference appeared between the series: the ratio of the times for an equal regression (50%) with x rays or electrons was equal to 0.75. At that time it was found that the calibration factor of the ionization chamber was 5% smaller for electrons than for x rays, and that from random fluctuations the average spacing of the fractions was 2% longer for electrons. Calculations of cell survival were carried out on a cellular model (D_0 = 150 rads and n = 3) within the actual conditions of the clinical trial. They showed that, assuming the same RBE, the ratio of the times for the same cell survival is equal to 0.85. The comparability of the calculated curves and the clinical curves is then discussed. The difference between the two figures (0.75 and 0.85) is not significant, and thus the difference in dose per fraction and spacing can account for the difference in the clinical curves. Some other discrepancies between the two kinds of irradiation are discussed. Thus, a trial designed to investigate the influence of the nature of the radiations showed a difference that was in fact related to time factors. This trial showed the feasibility of such an investigation, but stressed the necessity of controlling with the greatest care the similarity of the factors outside the scope of the investigation. A correlation between clinical and basic data was obtained, but it lay outside the field originally considered. (auth)

6544 FACTORS AFFECTING THE TUMOUR CONTROL RATE IN PATIENTS TREATED WITH 10 TO 35 MeV ELECTRONS. Gillies, J. M.; Johnson, R. J. R.; Walton, R. J. (Manitoba Cancer Treatment and Research Foundation, Winnipeg, Can.). pp 128-39 of Electron Beam Therapy. Vaeth, Jerome M. (ed.). Basel, S. Karger AG, 1968.

From Conference on Electron Beam Therapy, San Francisco. See CONF-661065.

Experiments to date with electron therapy indicate that when standard daily fractionation was used, a dose of 6500 to 7000 rads in 30 treatments in 42 days was within the skin tolerance. A comparable dose given in 20 treatments in 28 days was 5600 to 6000 rads. A degree of tumor control was obtained that would correspond very closely with our previous experience of cobalt therapy. Advantage was taken of the physical characteristics of the electron beam in selecting cases suitable for treatment by this method. The tolerance of previously irradiated skin particularly on the chest wall observed by many others was confirmed. Use was made of iso-effect tables to normalize a wide range of dose-fraction combinations in order to permit comparison of their effects. (auth)

6545 PYRIMIDINES AND THE X-RAY RESPONSE OF TRIBOLIUM CONFUSUM DUVAL. Hogan, G. Richard (Univ. of Illinois, Urbana). Radiat. Res., 36: 352-64(1968).

Radiosensitizing effects of incorporation into DNA of the halogenated pyrimidines 5-bromouracil or 5-iodouracil, or their nucleosides (BUdR and IUdR), were demonstrated in a variety of cell types. The results indicated that these antimetabolites influenced lethality in x-irradiated adult Tribolium. At relatively low concentrations in the medium, BUdR and IUdR exhibit toxicity three to five weeks after transfer of beetles to analog-containing medium. Toxicity of IUdR on nonirradiated adults was less pronounced than that of BUdR and was slower to develop. Analog-treated Tribolium exposed to 7 kR, that is sublethal for adults in normal medium, died much earlier than those treated with analog alone or with lethal doses of x rays alone. Transfer of beetles to normal medium after three weeks or less in the presence of analog virtually eliminated lethality attributable to the analog. X irradiation at the time of transfer, however, led to high mortality, and the amount of mortality appeared to be a function of the duration of analog treatment. Insects grown in medium containing uracil or thymine exhibited the same survival as those reared in unsupplemented medium. Two weeks after 7 kR of irradiation a sharp decline in survival was seen in both uracil- and thymine-treated groups. (auth)

6546 PROFILAKTIKA OSTROI LUCHEVOI BOLEZNI V EKSPERIMENTE. (Experimental Studies of Prevention of Acute Radiation Sickness). Semenov, L. F. Moscow, Izdatel'stvo Meditsina, 1967. 216p.

Results of 15 years of experimental work on protective measures against radiation sickness are reviewed. Theoretical concepts used as a basis in research on radioprotective measures are also discussed. A special chapter is dedicated to the pharmacological and toxic effects of radioprotective measures on the organism. (R.V.J.)

6547 SELECTIVE ENHANCEMENT OF RADIOTHERAPEUTIC EFFECTS BY MANIPULATED TUMOR ACIDITY AND HEAT. von Ardenne, M.; Chaplain, R. A. (Forschungsinstitut, Dresden). Naturwissenschaften, 55: 448(Sept. 1968). (In German).

In order to test whether by combination of optimized selective tumor overacidification and hyperthermy with ionizing radiation, an improvement with respect to the selectivity and therapeutic effect would be possible, in-vitro measurements were made on EMAC cell suspensions after an x-ray exposure of 1000 R at 40°C and pH values varied by lactic acid additions. The $t_{LD_{50}}$ values were graphed. These results show that with x-ray exposure at pH = 6.3 and 40°C hyperthermy the LD_{50} was attained in 330 min, whereas without x irradiation this was the case at pH = 6.0. Therefore by combination of hyperthermy and overacidification with ionizing radiation, the therapeutic effect in tumors was attained with very reduced radiation doses. (J.S.R.)

6548 RADIOSENSITIVITY AND POSSIBILITIES OF RADIOPROTECTION OF LACTIC DEHYDROGENASE OF AN EMBRYONIC CHICKEN ORGAN CULTURED IN VITRO. Kirrmann, J.-M. (College de France, Nogent-sur-Marne). Arch. Sci. Physiol., 21: 415-27(1967). (In French).

The effects of x rays on oxygen consumption and on glycolysis under aerobic conditions were observed in a study of the respira-

tory metabolism of cultured embryonic chicken organs. Embryonic intestine of chicks incubated for 12 days was removed and irradiated with varying doses of x rays at 1500 R/min at 50 to 60 KV and 15 mA and a focal distance of 11 cm. Assays of enzymatic activity were made 4, 24, and 48 hr after irradiation. With a dose of 7500 R a 20% inhibitory effect on respiration was observed. Since cysteamine has a radioprotective effect on intestine in vivo, an attempt was made to detect a radioprotective effect in vitro against the action of x rays on the lactic dehydrogenase (LDH). The inactivation-dose curves for radiosensitivity of LDH were different when the enzyme was irradiated in the cultured organ and in solution (bovine heart LDH). The former necessitated larger amounts of cysteamine than the latter for radioprotection. Thus, the presence of 1 mM cysteamine reduced the inactivation of LDH in solution from 96 to 8% after 100 KR. It was concluded that there was a close similarity between the action of radiation on respiratory metabolism as a whole and on a single enzyme involved in respiration, particularly in relation to radioprotection against the effects of irradiation. (BBB)

6549 SOME CONSIDERATIONS ON THE PROBLEMS INVOLVED IN RADIATION INJURY COUPLED WITH BURNS. Vallo, Jozsef; Novak, Janos. Honvedorvos, 20: 163-73(Apr.-June 1968). (In Hungarian).

Problems involved in injuries caused by ionizing radiation coupled with thermal trauma were investigated, using data published in the literature and experiences gained in treating patients. One of the problems was that the usefulness of the lymphocyte number drop to establish radiation injury was less dependable in cases where the patient suffered severe burns also. The possibility and accuracy of prognoses on the basis of examination data, and on the indications of amputation in cases of severe injury of limbs by radiation were discussed. (JPRS)

6550 A CYTOGENETIC STUDY OF DOWN'S SYNDROME IN HIROSHIMA AND NAGASAKI. Slavin, Richard E. (Baltimore City Hospitals); Kamada, Nanao; Hamilton, Howard B. Jinrui Idengaku Zasshi, 12: 17-28(July 1967).

A survey by the Atomic Bomb Casualty Commission was reported on patients with Down's syndrome in eight schools for mentally retarded children, five in Hiroshima and three in Nagasaki. Of the 101 patients examined cytologically, 92 (57 in Hiroshima and 35 in Nagasaki) had chromosomal abnormalities consistent with the clinical diagnosis of Down's syndrome. Two patients, mosaics, had two distinct cell lines: about 50% of the cells contained the normal chromosome complement of 46 while the remaining contained 47 chromosomes with 21 trisomy. Three cases had modal chromosome numbers of 46 with D/G translocations. One patient, with a modal number of 46, had in addition to 21 trisomy, a D/D translocation. Although parents (one or both) of several of the patients were exposed to the atomic bomb either in Hiroshima or Nagasaki some time before conception, most doses of radiation were very low. The mother of one case, at 1630 m from the hypocenter, could have received a maximum estimated air dose of 16 rad. All other exposed parents were beyond 2000 m and with one exception, the mother of a case whose dose estimate was eight rad, were beyond the point in either city where the maximum estimated air dose was one rad (2180 and 2740 m respectively for Hiroshima and Nagasaki). Hence, with the two exceptions noted, the exposed parents probably received very small amounts of radiation at the time of the bomb. (BBB)

6551 SIGNIFICANCE OF FOCUS SIZE IN IRRADIATION THERAPY. Klami, P. (Univ. Hospital, Turku, Finland). Acta Radiol., Ther., Phys., Biol., 7: 273-81(Aug. 1968).

The possibilities of using radiation sources with anodes of large area in radiation therapy are explored. It is concluded that the focus-object distance can be greatly reduced without influencing the per cent depth dose if the radiation is divided into a number of collimated beams. (INIS) (Sweden)

6552 EFFECT OF β-AMINOETHYLISOTHIURONIUM-BROMIDE-HYDROBROMIDE ON THE ACETATE-1-^{14}C INCORPORATION INTO TISSUE LIPIDS OF IRRADIATED RATS. Naqvi, S.; Kumar, K. S.; Venkitasubramanian, T. A. (Univ. of Delhi). Experientia, 24: 891-2(Sept. 15, 1968).

Rats were divided into four groups: controls, those given 2400 R γ radiation, those given AET prior to irradiation, and those given AET alone. Injections of ^{14}C-labeled sodium acetate were given 46 hr after irradiation and rats were sacrificed two hr later. Total lipids of tissue extracts were determined. The tabulated results show that the maximum increase of acetate incorporation following irradiation occurred in the liver; the increase in the kidneys was somewhat less, and still less in the spleen. In all cases the effect of AET was to reduce the incorporation of acetate in the tissues. (H.L.W.)

6553 POSSIBILITIES AND ADVANTAGES OF USING NEGATIVE PIONS IN RADIOTHERAPY. Rosen, Louis (Los Alamos Scientific Lab., N. Mex.). Nucl. Appl., 5: 379-88(Dec. 1968).

Recent advances in accelerator technology make possible the attainment of very-high-intensity beams of protons at energies well above the pion-production threshold. It appears that both circular and linear machines will be useful for this purpose. The latter promise beams of ≥1 mA under well-controlled conditions. Such proton beams are adequate for providing pure high-intensity beams of negative pions for radiation therapy, under conditions of favorable geometry and of variable size and energy distribution. With π^- beams it is feasible to deposit, at essentially any depth in the human organism, at least 100 rad/min of high-LET radiation. This is quite sufficient for radiation therapy on deep-seated tumors and is accomplished under more favorable conditions than attainable with other radiation sources. (auth)

6554 CELL-CYCLE-DEPENDENT PROTECTION BY CYSTEAMINE AGAINST X-RAY-INDUCED CHROMOSOME ABERRATIONS. Yang, Shung-jun; Hahn, George M. (Stanford Univ. School of Medicine, Palo Alto, Calif.). Int. J. Radiat. Biol., 14: 71-3(1968).

Cysteamine protection against x-ray-induced chromosome aberrations in Chinese hamster cells, both with and without preincubation in bromodeoxycytidine (BCdR), is reported. In both cases, the extent of protection varied with phases of the cell cycle. (auth)

6555 EFFECT OF DOPAMINE ON DNA X-IRRADIATED IN VITRO. Prasad, Kedar N. (Univ. of Colorado, Denver); Vanwoert, Melvin H. Int. J. Radiat. Biol., 14: 79-82(1968).

The radioprotective effects of dopamine on DNA solutions irradiated in vitro were studied. The DNA solution x irradiated with 200 kR showed no visible precipitate when diluted with 0.1 N $HClO_4$; the control DNA precipitated. This was consistent with the finding that irradiation of DNA in vitro causes chain breaks that result in several smaller polynucleotides. The DNA solution irradiated in the presence of dopamine showed visible precipitate that indicated that dopamine probably reduced the number of chain breaks resulting in polynucleotides large enough to precipitate in perchloric acid. Irradiated DNA solution did not precipitate if dopamine was added after irradiation and before treatment with $HClO_4$. No quantitative determination of the amount of precipitate was made. (auth)

6556 BRAIN SCANNING WITH RADIOACTIVE TECHNETIUM (^{99m}Tc). Carteri, A.; Vianello, A.; Ferlin, G.; Ziliotto, D. (Univ., Padua). Acta Isotop., 7: 341-53(Dec. 30, 1967). (In Italian).

Preliminary results in brain scanning using ^{99m}Tc are reported. The main advantages were: possibility of using high doses, low patient irradiation, and time saving. These features were the result of the peculiar physical characteristics of the substance (low energy γ rays, lack of β particle emission, and short half-life). Another important advantage was the possibility of obtaining an immediate scan (a few minutes after the injection of the tracer) without special patients care. As far as reliability was concerned, ^{99m}Tc did not seem to offer any advantage over the usual tracers. On the contrary, there might be some limitation in the use for the detection of lesions of the posterior fossa. In these cases, muscular, vascular, and bone structures might sometimes mask the lesion. (auth)

Radiation Effects on Animals

Refer also to abstract 6415.

6557 SIMPLE UV-MICROBEAM FOR PARTIAL CELL IRRADIATION. Rustad, R. C. (Case Western Reserve Univ., Cleveland). Contracts AT(40-1)-2730; W-31-109-eng-78. Experientia, 24: 974-5(Sept. 15, 1968). (COO-78-172).

Small areas of the cell can be irradiated if the ultraviolet light from a monochromator is limited by interchangeable apertures of the field in the plane of the photographic film of a reflex apparatus mounted on a microscope. The uv image is demagnified by an ocular and an achromatic objective as well as by visible uv light. (tr-auth)

Invertebrates

Refer also to abstracts 6344, 6388, 6404, 6407, 6421, 6423, 6545, 6627, and 6628.

6558 (AD-671943) DIFFERENTIAL LETHAL EFFECTS OF MIXED REACTOR RADIATIONS ON LOGARITHMIC-PHASE AND SYNCHRONIZED TETRAHYMENA PYRIFORMIS. Nachtwey, D. S. (Naval Radiological Defense Lab., San Francisco, Calif.). Apr. 29, 1968. 18p. (USNRDL-TR-68-53). CFSTI.

Logarithmic-phase and heat-shock synchronized Tetrahymena pyriformis cells were subjected to mixed neutron-gamma radiations (2.7:1) from a Mark F Triga reactor. A median lethal dose (LD50/48 hr) for logarithmic-phase cells was 70 krads (95% confidence interval: 68 to 73). The LD50/48 hr for heat-treated cells irradiated at six min after the end of the synchronizing treatment was 174 krads (95% confidence interval: 170 to 178). The approximately 2.5-fold resistance of heat-treated cells relative to logarithmic-phase cells might be related to the fact that heat-treated cells at the end of the synchronizing treatment contain 2 to 4 times the amounts of DNA found in logarithmic-phase cells. However, since heat-treated cells also are 2 to 4 times larger and contain 2 to 4 times the amount of RNA, other factors cannot be excluded. The possibility that the resistance of synchronized cells results from being irradiated at a particularly insensitive stage in the cell cycle is discussed; it is concluded that this explanation is unlikely. (auth) (USGRDR)

6559 PRELIMINARY STUDY ON THE STIMULATING EFFECT OF LOW DOSE GAMMA RADIATION ON THE LARVAE OF SILK WORM, (BOMBYX MORI). Mallik, M. U.; Hossain, M. M.; Mollah, S. A. (Atomic Energy Centre, Dacca, Pakistan). Nucl. Sci. Appl., 4: 19-20(Apr. 1968).

Weight gain was used as the criterion for radiation effects on feeding rate or assimilation capacity of silk worms. Larvae were irradiated at doses of 100 to 400 R with a ^{60}Co source. It was found that stimulation was dependent on stage of development. The fifth larval stage was stimulated most. All irradiated larvae showed increased weight except those irradiated in the third stage. Low-dose irradiation increased the weight of cocoons by 10 to 15%. Doses of 100 and 200 R were the most effective in stimulation. Possible explanations for these findings are discussed. (C.O.)

6560 RADIATION SUSCEPTIBILITY OF THE FLOUR BEETLE TRIBOLIUM CONFUSUM. Hossain, M. M.; Hossain, M.; Rahman, R.; Mollah, S. A. (Atomic Energy Centre, Dacca, Pakistan). Nucl. Sci. Appl., 4: 7-10(Apr. 1968).

During a study of the susceptibility of the confused flour beetle, Tribolium confusum J. duv (adult), to γ radiation a mass rearing of the species was maintained. The rearing experiment was maintained on the food source of milled flour at 28 ± 2°C and 80 ± 5% relative humidity. Adults of the same age were than exposed to different doses up to 25 kR to find out the mortality of the population. It was found that 100% kill is possible within thirteen days after exposure to 16 kR to 25 kR. (auth)

6561 ESTIMATES OF SOME COMPONENTS OF FITNESS IN DIPLOID PARTHENOGENETIC ARTEMIA SALINA IRRADIATED OVER SEVERAL GENERATIONS. Ballardin, E.; Metalli, P. (CNEN, Rome). Atti Ass. Genet. Ital., 13: 341-5(1968). (In Italian).

From Conference on Genetics, Naples, Italy. See CONF-671057-(Vol.13).

Three lines of diploid parthenogenetic Artemia salina (brine shrimp) were studied to determine to what extent their fitness was affected by irradiation. Random samples of 70 brine shrimp were drawn from each mass-cultured line at each generation to give offspring for the next. The animals were irradiated in the juvenile stage (about 14 to 16 days old) with 0, 500, and 1000 rad of x rays (240 kV) for the three lines respectively. The germ cells were at the oogonia stage during irradiation. Diapause cysts were discarded and only larvae hatched from viviparous broods were used for new cultures. The data reported are restricted to viviparity. Number of eggs produced, hatchability, and percentage of larvae that survived to the adult stage were used as criteria of fitness. The irradiated lines did not show a change in fitness compared to the control line until the 7th generation. In the 8th generation there was a drop in most of the measured components of fitness. The average relative number of descendants that survived to reproductive age dropped to about half after 3,500 rad and about a quarter after 7000 rad total accumulated dose. Using these criteria Artemia appear to be more radiosensitive than Drosophila. (M.M.B.)

6562 A STUDY ON THE NUCLEAR POLYHEDROSIS VIRUS ON THE BEET ARMYWORM, SPODOPTERA EXIGUA (HUBNER), WITH EMPHASIS ON STABILITY, PATHOGENICITY AND HISTOPATHOLOGY. Hunter, Douglas Kent. Riverside, Calif., Univ. of California, 1967. 90p.

Thesis.

In the United States, the beet armyworm, Spodoptera exigua (Hübner), is a relatively serious pest on truck and field crops throughout the Gulf states and westward to the Pacific Coast. A nuclear polyhedrosis virus of this pest was diagnosed in 1955, but little has been reported on the disease since that time. Studies were undertaken to ellucidate many of the more important aspects of the pathogen and its interrelationship with its host. A culture of S. exigua was maintained on artificial diet for test purposes. Initial experiments were carried out to determine the stability of the virus. It was observed that formaldehyde, hydrogenion concentration, high temperatures, and long wave ultraviolet irradiation played important roles in virus inactivation in vitro. A bioassay of polyhedral suspensions was conducted to determine pathogenicity. The first four instars of S. exigua were fed diet upon which polyhedra had been evenly layered. This technique ensured a natural means of infection and could be amenable to field situations. LD_{50}s for the four respective instars were 14, 27, 47, and 86 polyhedra/mm^2 of diet surface. LT_{50}s ranged from 4.1 to 7.0 days. Resistance was shown to be proportionally greater with successive instars. Pupal mortality, due to virus, tended to increase with dosage. Temperature studies with continuous vs. controlled exposure to polyhedra showed that degree of larval mortality was only related to metabolism when virus dosage was equal. Initial incubation of larvae on virus-layered diet at various temperatures resulted in unequal pathogen consumption and resulted in unexpected mortality trends. A histopathological study was conducted utilizing light and electron microscope techniques. Successive stages of infection were observed in affected tissues, especially the fat body. Suggestions on the exact site of polyhedral and virus membrane protein are given. Virus and polyhedral development was noted. Inclusion body size and the average number of virus particles/bundle were determined. (Diss. Abstr.)

6563 FORMATION AND SIZE REGULATION CAPACITY OF THE SEROSA IN MALE EMBRYOS OF THE MEALY BUG, PSEUDOCOCCUS OBSCURUS ESSIG. Bregman, Allyn Aaron. New York, Univ. of Rochester, 1968. 84p.

Thesis.

The development of the serosa or embryonic covering is described for males of the coccid, Pseudococcus obscurus Essig. The cells of part of this tissue are typical of males having the parental chromosome set heterochromatic and genetically inert. The cells of the remainder of the tissue have the chromosome contributions of both parents in the euchromatic state. Observations on cells undergoing reversal from the heterochromatic to euchromatic state are described. Experiments were designed to test the size regulation capacity of the tissue. Euchromatic serosa cells (ESC) were selectively damaged or destroyed by paternal x irradiation (PI) causing genetic damage to one set, direct ultraviolet irradiation of ESC, and interspecific mating to introduce foreign genetic information. The effect of these treatments on serosa composition was studied. Following PI, the fewer ESC were usually not accompanied by more heterochromatic serosa cells (HSC). These results may still be consistent with size regulation since the size of individual ESC increased. After uv irradiation, the fewer ESC were consistently accompanied by extra HSC. Following interspecific mating, the hybrid ESC remained unchanged in number and size, but the HSC increased in number. Within almost all groups, regardless of treatment, negative correlations between the numbers of ESC and HSC were found. This finding and the uv results support an area compensation model for the completion of the serosa. The model is that a change in the number of ESC or in their total area is accompanied by a compensatory change in the number of HSC. (Diss. Abstr.)

Vertebrates

Refer also to abstracts 6338–6343, 6345, 6356, 6358, 6364–6370, 6372, 6376–6379, 6385–6387, 6389, 6392–6394, 6396, 6400, 6402, 6404, 6408, 6424, 6429, 6433, 6494, 6524, 6546–6548, 6552, 6554, and 6620.

6564 (BNWL-714, pp 1.1-20) RADIATION EFFECTS STUDIES. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

X RADIATION—effects on morphology of cells of intestinal mucosa in rats, effects of pancreatic fluid on
—effects on electrolyte transport in intestines of rats
—effects on content of albumin in blood serum and lymph in intestines of rats
—effects on survival of alligators, effects of dose on whole-body

SWINE—radioinduced carcinomas of skin in, following topical application of ruthenium-106, β
—radiation effects on, following intradermal injection of plutonium, latent pathological
—survival of transfused autologous erythrocytes in

GAMMA RADIATION—effects on salmon, effects of dose on pathological (C.H.)

6565 (BNWL-714, pp 2.1-23) ^{90}Sr STUDIES IN MINIATURE SWINE. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The effects of β particles on various physiological criteria in swine following chronic or single injection of ^{90}Sr are described. Among the criteria that were rated were the following: incidence of malignancies; content of alkaline phosphatase, alanine aminotransferase, aspartate aminotransferase, and lactate dehydrogenase in blood serum; content of albumin in blood serum; content of globulin in blood serum; and generation time in cell cycle of hematopoietic cells. (E.R.B.)

6566 (EUR-3938) EXPERIMENTAL AND CLINICAL RESEARCH ON THE PHYSIOLOGY, PATHOPHYSIOLOGY, AND RADIOPATHOLOGY OF THE HAEMTOPOIETIC SYSTEMS. I. PROLIFERATION-KINETIC AND RADIOBIOLOGICAL TESTS ON BLOOD-CELL FORMATION. Annual, 1965-1966. Fliedner, T. M. (Gesellschaft fuer Strahlenforschung m.b.H., Freiburg (West Germany). Institut fuer Haematologie). Apr. 4, 1968. 122p. (In German). Dep.

The hematology program of the Euratom/GSF Association involves clinical and experimental research into radiation-induced changes in the hemopoietic system, which are among the extremely important radiation hazards over a wide irradiation range. The program will be carried out by two research teams whose work is complementary and closely linked: the Freiburg team is concerned mainly with kinetic examinations on hemopoiesis, whereas the Munich team is dealing essentially with the adaption of various predominantly biophysical and biochemical methods of nuclear medicine to the observed clinical phenomena. The work carried out by the Freiburg team is described in Part I of the Association's Annual Report. Part II, which is to appear as a special publication, deals with the work of the Munich team. (auth) (TSS)

6567 (JPRS-44299, pp 77-85) SOME INTERPRETATIONS OF THE BIOLOGICAL EFFECT OF CHRONIC γ-IRRADIATION. Khoruzhenko, A. F.; Laptev, A. I.; Oreshkin, I. G.; Malakhovskii, V. N.; Rezontov, V. A. Translated from Kosm. Biol. Med., 1: No. 5, 52-7(1967).

Rats were exposed daily to fractional ^{60}Co γ irradiation, the duration of exposure ranging from one to 90 days in different experiments. As the duration of exposure increased, the magnitude of the median lethal dose increased in an asymmetrical sigmoid relation. The correlation was analyzed using the method of a quantitative expression of the radiobiological effect through dose units. On this basis it was possible to develop a model of accumulations and repair of radiation damage associated with chronic exposure to γ rays. The results obtained are in agreement with the idea of monotonic repair of the elementary damage with a 20% level of irreversibility. As a result, the lethal response of the animals to chronic γ irradiation appears similar to that of acute γ irradiation. (auth)

6568 (N-68-23533) RADIATION-INDUCED NUCLEIC ACID SYNTHESIS IN L CELLS UNDER ENERGY DEPRIVATION. Sanders, J. L.; Dalrymple, Glenn V.; Baker, Max L.; Wilkinson, K. P.; Dixon, Paul A. (Arkansas Univ., Little Rock). Dec. 1967. 31p. (NASA-CR-73220). CFSTI.

L cells showed a brief, accelerated uptake of radioactive precursor into both DNA and RNA following exposure to relatively low doses of x radiation. This response appeared for cells being starved in a glucose-free salt solution and for cells treated with 2,4-dinitrophenol. Three distinct features characterized the response. First, a relatively fixed postirradiation time delay seems necessary before the accelerated labeling of the nucleic acids occurs. Second, the labeling of the DNA fraction closely parallels the labeling of the RNA fraction. Finally, the radioactive label appears to enter and then to leave both nucleic acid fractions. Although the accelerated labeling was most apparent after 100 Rads, it also happened at higher doses where several cycles of incorporation and loss of label appeared. Since comparable changes were not found under normal growth conditions, this response presumably resulted because of the energy-deprived state. Both continuous labeling and pulse methods were used; the nucleic acids were labeled with either inorganic phosphate ^{32}P or radioactive precursors specific for a given fraction. Survival studies indicated that cells treated with 2,4-dinitrophenol had an increased resistance to x rays. (STAR)

6569 (NSJ-tr-95) RADIATION DEATH IN ANIMALS. RELATIONSHIP BETWEEN LETHAL EFFECTS ON ANIMALS AND CELL DEATH. Egami, Nobuo. Translated from Kagaku (Tokyo), 36: 140-6(Mar. 1966). 20p. Dep. JCL $1.60 fs, $0.80 mf.

It is pointed out that the critical organs are important in acute radiation deaths in lower vertebrates as in mammals. The relation between the period of survival after exposure to x rays and the dose of radiation was studied in goldfish and other teleost fishes. The dose-survival time curves for fishes are similar in shape to mammals, and hematopoietic, intestinal, and brain deaths are clearly distinguishable from these curves. In fish, the length of survival time varies with the post-irradiation temperature. Cell population kinetics were studied with ^{3}H-thymidine in critical organs at different temperatures, and the relation between the length of generation time of critical cells and survival period of the fish is discussed. (auth)

6570 (NSJ-tr-107) ATROPHY OF GENITAL ORGANS OF YOUNG AND ADULT MICE IRRADIATED WITH 14.1 MeV FAST NEUTRONS AND 180 kVp X-RAYS. Yamamoto, Osamu. Translated from Nippon Igaku Hoshasen Gakkai Zasshi, 26: 1237-41 (1966). 10p.

Genital organ atrophy in young and adult mice irradiated with 14.1 MeV fast neutrons and 180 kVp x rays was studied. For testicle in both adult and young mice, remarkable atrophy was observed. Seminal vesicle atrophy in adult male mice, and ovarian and uterine atrophy in adult female mice were not so marked, while these organs of young mice were very sensitive to radiation. The greater weight differences among genital organs resulting as a function of radiation dose in young mice should be referred to as growth suppression rather than atrophy. RBE values obtained for fast neutrons to x rays were as follows: for adult male mice, body weight loss 1.81, and testicular atrophy 2.76 (1/2) weight) and 1.65 (1/e weight); for adult female mice, body weight loss 2.13; for young male mice, body weight loss or growth suppression 1.68, testicular atrophy or growth suppression 2.70 (1/2 weight) and 2.27 (1/e weight), and seminal vesicle atrophy or growth suppression 1.93 (1/2 weight) and 1.91 (1/e weight); and for young female mice, body weight loss or growth suppression 1.92, ovarian atrophy or growth suppression 3.19 (1/2 weight), and 2.28 (1/e weight), and uterine atrophy or growth suppression 1.74 (1/2 weight) and 1.54 (1/e weight). (auth)

6571 (NYO-3314-12) GENETIC CONTROL OF AGING AND RADIATION-INDUCED LIFE-SHORTENING IN MICE. Progress Report, October 1, 1967-September 30, 1968. Yuhas, John M. (Jackson Lab., Bar Harbor, Maine). Contract AT(30-1)-3314. 93p. Dep. CFSTI.

Objectives are to test the somatic mutation theory of aging and radioinduced life shortening. If strain differences are obtained and are correlated according to the predictions of the somatic mutations theory, this will be strong indirect evidence in support of the somatic mutation theory. Lack of strain differences or inconsistencies in the correlations cannot disprove the somatic mutation theory, but indicate that it is an oversimplification. A secondary objective is the analysis of the effects of age and genetic factors in the determination of resistance to and recovery from ionizing radiation exposure. Progress is reported on the following aspects of these studies: associated pathology at death; strain differences in the rate of aging; inheritance of the rate of aging; radioinduced life shortening; correlation between the rate of aging, genetic stability, and resistance to radioinduced life-shortening; age and radiation effects on gross brain composition; the central nervous system syndrome of the mouse; system involvement in residual injury as a function of age; strain differences in radiation response of hematopoietic stem cells; the time course of recovery from radiation injury in the mouse; and maternal effects on radioinduced dominant lethal mutations in spermatozoa. Tables are presented to show associated pathology at death in organs of inbred strains and hybrids as a function of radiation dose; mean survival time of mice in relation to radiation dose and pathology; and life shortening as a function of dose calculated from displacements of Gompertz plots for mice of different genotypes. (H.L.W.)

6572 (NYO-3917-1) MORPHOLOGICAL AND HISTOCHEMICAL CHANGES IN BONE CELLS AFTER IRRADIATION; A LIGHT AND ELECTRON MICROSCOPIC STUDY. A Progress Report, October 1, 1967-September 30, 1968. Doty, Stephen B. (Johns Hopkins Univ., Baltimore, Md. Dept. of Radiological Sciences). Contract AT(30-1)-3917. 11p. Dep. CFSTI.

Progress is reported on studies of the effects of internal irradiation from injected ^{45}Ca on the morphology and physiology of bone cells in swine. Electron microscopic examinations were made of bone cells at various times from 15 min to 14 days following the administration of 25 μCi or 100 μCi of ^{45}Ca. Autoradiograms were used to determine the localization of ^{45}Ca in the bones and in isolated liver mitochondria. The activity of ATPase was found to be higher at seven days following the administration of ^{45}Ca, as compared to two days or 14 days. (C.H.)

6573 FUNCTIONAL AND MORPHOLOGICAL CHANGES IN THE RESPIRATORY SYSTEM AND THE INTESTINAL TRACT AT LATE STAGES OF CHRONIC RADIATION SICKNESS. Kishkovskii, A. N. Voenno-Med. Zh., No. 11, 34-6(Nov. 1967). (In Russian).

A total of 210 rabbits was given a whole-body, daily dose of 5, 10, and 25 R x radiation with total doses of 800, 1000, and 1500 R, respectively. A group of 35 rabbits served as controls. The animals were placed under clinical observation for a period

of three years, and studies were made of the blood picture and the state of the organs by roentgenography and bronchiography. The irradiated animals were subject to more complications, and died earlier than the control animals. The x-ray pictures showed hypotonus of the bronchi, chronic pneumonia, lung emphysema, and diffuse pneumosclerosis. The motor-evacuatory function of the GI tract was found to be impaired because of hypotonus. Significant atrophy of the mucous membrane and lymphatic vessels was noted. It is suggested that the taking of x-ray pictures is a valuable method in recognizing and dealing with the functional and morphological changes accompanying chronic radiation sickness. (TTT)

6574 CANCERS INDUCED IN DIFFERENT SPECIES BY CONTINUOUS γ-RADIATION. Warren, Shields; Gates, Olive (New England Deaconess Hospital, Boston). Arch. Environ. Health, 17: 697-704(Nov. 1968).

Species and strains of animals differ in their tendency to develop tumors spontaneously and also in the prevalent tissues and cell types involved in this development. We have found that a γ source of continuous radiation (^{60}Co wires) implanted in young adult rodents and capable of inducing cancers of the types expected in this species will also produce cancers which rarely develop spontaneously. These are epidermoid carcinoma of the esophagus and lung and also osteogenic sarcoma. Radiation carcinogenesis tends to override expected differences in susceptibility of species and strains. The rat appears highly susceptible to lung cancer, the mouse and hamster only slightly susceptible to osteogenic sarcoma. There appear to be optimal dose and dose-rate ranges for carcinogenesis but these may be obscured by biological variations. (auth)

6575 PATHOMORPHOLOGICAL PECULIARITIES OF RADIATION DISEASE IN ANIMALS IRRADIATED WITH HIGH ENERGY PROTONS. Shikhodyrov, V. V.; Lebedev, B. I. Kosm. Biol. Med., 2: No. 5, 8-11(Sept.-Oct. 1968). (In Russian).

Test dogs were irradiated with protons of 126 and 510 MeV using single and repeated irradiations with doses of 250 to 700 rads. Certain peculiarities in the pathomorphological picture of radiation disease were found. They included hemorrhagic diathesis and disorders of the hemopoietic and nervous systems. Changes developing at long intervals after irradiation were detected. (auth)

6576 CYTOPLASMIC ULTRAVIOLET EXTINCTION OF ^{90}Sr-INDUCED FIBROBLASTIC OSTEOSARCOMAS CORRELATED TO HISTOLOGIC APPEARANCE AND ULTRASTRUCTURE. Sundelin, Paer; Nilsson, Agnar. Acta Radiol., Ther., Phys., Biol., 7: 161-70(June 1968).

The development of osteosarcomas in mice following intraperitoneal injection of ^{90}Sr was investigated by means of uv microphotometry and electron microscopy. Successively increasing uv extinction values could be correlated to morphologically more advanced stages of tumor development. (auth)

6577 RADIOSENSITIZING ACTION OF HALOGEN SUBSTITUTED THYMIDINE ANALOGS. Pelevina, I. I.; Afanas'ev, G. G.; Lipchina, L. P.; Emanuel, N. M. (Inst. of Chemical Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Biol., No. 3, 345-52(May-June 1968). (In Russian).

Administrations of 5-iodo-2-deoxyuridine (IUdR) to mice with subcutaneously transplanted lymphosarcoma NKLy and subsequent local irradiation of tumors result in enhancement of lethal action of irradiation and increase in animals with resolved tumors. The rate of sensitization increases with the dose of IUdR. The deviation from the normal distribution of tumor diameters after the combined action of IUdR and irradiation was shown. This phenomenon is connected with the heterogeneity of tumors and with their different sensitivity to the treatment used. The growth rate of unregressed, resistant tumors does not change and is equal to the control tumors. 5-chloro-2-deoxyuridine (ClUdR) possesses antitumor activity. After the combined action of this chemical and irradiation the effect was additive. (auth)

6578 A COMPARISON OF THE CHRONIC EFFECTS OF IRRADIATION UPON THE NORMAL, DAMAGED, AND REGENERATING RAT LIVER. Dettmer, Cornelia M.; Kramer, Simon; Driscoll, Dorothy H.; Aponte, Gonzolo E. (Jefferson Medical Coll. Hospital, Philadelphia). Radiology, 91: 993-7; 990(Nov. 1968).

The long-term effect of irradiation upon normal, damaged, and regenerating rat liver was studied by means of the following parameters: mortality, body-weight changes, liver function as measured by ^{131}I-rose bengal uptake, and histologic abnormalities. A single dose of either 1,000 rads or 2,500 rads x radiation was delivered to the whole liver and the animals were followed for one year. All data confirm the fact that the late effects of liver irradiation will vary according to the condition of the liver cell at the time of irradiation. The normal cells show late damage probably manifest only after these resting cells are stimulated to divide. Irradiation in the presence of hepatocellular damage results in more severe injury, and many more cells fail to recover. On the other hand, liver cells irradiated during active division are more efficient in repairing radiation damage and show the fewest chronic changes. (auth)

6579 DOSE-SURVIVAL CHARACTERISTICS OF EPITHELIAL CELLS OF MOUSE INTESTINAL MUCOSA. Withers, H. R.; Elkind, M. M. (National Cancer Inst., Bethesda, Md.). Radiology, 91: 998-1000(Nov. 1968).

A technic for cloning crypt cells of mouse jejunum is described. With this method the dose-survival relation for these cells following exposure of intestinal loops to x radiation was determined. The slope of the exponential portion of the survival curve was fairly steep ($\bar{D}_0$ = 100 R), but the capacity of these cells for repair of sublethal injury, as determined by dose-fractionation methods, appeared to be large. The significance to radiotherapy of the patterns of recovery exhibited by several different in vivo cell systems during the first fourteen hours postirradiation is briefly discussed. (auth)

6580 USE OF RADIOIRON (^{59}Fe) AS AN INDEX TO HEMOPOIETIC DAMAGE CAUSED BY IONIZING RADIATION. Kitchings III, J. T.; Dunaway, P. B.; Story, J. D.; Tucker, L. E. (Oak Ridge National Lab., Tenn.). J. Tenn. Acad. Sci., 43: No. 3, 85-7(July 1968).

Elimination rates and biological half-lives of ^{59}Fe in seven species of wild rodents ranged from Oryzomys palustris (λ_b = 0.18%, T_b = 385) to Reithrodontomys humulis (λ_b = 0.50%, T_b = 137). No significant difference in retention of ^{59}Fe was noted after injections of 0.475 μCi or 0.110 μCi. The animals were exposed to γ radiation on the one hundred-fourteenth day of the experiment. One group (400 rad) exhibited no decrease in iron retention with the exception of radiosensitive rice rats, while in the other group (doses approaching the LD_{50-30}) all species except the house mouse showed a marked decrease in retention. It is believed that the normal mechanism involved in the return of hemoglobin disintegration products, notably released iron, to the hemopoietic system is impaired. A discussion of renal elimination of the released iron is presented. (auth)

6581 FOOD INTAKE AND GROWTH OF BURRO FOALS AFTER 250 ROENTGENS OF ^{60}Co WHOLE-BODY GAMMA IRRADIATION. Knapka, J. J.; Brown, D. G.; Barth, K. M. (Univ. of Tennessee, Oak Ridge). Contract AT(40-1)-Gen-242. Radiat. Res., 36: 158-65(1968).

Possible late effects of sublethal levels of whole-body γ irradiation on growth of burro foals were studied. Two trials included 31 nonirradiated foals and 32 foals that were exposed to 250 R of ^{60}Co γ radiation during their fourth month of life. The foals were weaned 90 days postirradiation and allotted into treatment groups based on radiation treatment, weight, sex, and size. Each group was then randomly selected to be fed a ration containing either 9%, 14%, or 18% crude protein in the first trial and either 9% or 18% in the second trial. The length of these trials was 364 days. Criteria used to evaluate the treatments included feed consumption, body weight gains, feed efficiency, increase in height, and increase in heart girth. Least-squares analysis of these data indicated that radiation had no significant effect on any of the traits tested. There was a consistent though nonsignificant trend for irradiated foals to be less efficient in feed utilization than their nonirradiated counterparts. (auth)

6582 FIBROBLASTOID TRANSFORMATION OF MALIGNANT MYELOBLASTS IN VITRO. Bubenik, J.; Donner, L.; Chyle, P.; Koldovsky, P.; Malaskova, Vera; Libansky, J.; Veprek, L.; Riman, J. (Inst. of Experimental Biology and Genetics, Prague. Inst. of Haematology and Blood Transfusion, Prague. Inst. of Organic Chemistry and Biochemistry, Prague). Folia Biol. (Prague), 14: 359-71(1968).

Malignant myeloblasts occurring after infection of chickens with avian myeloblastosis virus were isolated from blood of leukemic birds and seeded on monolayers of chicken embryo fibroblasts (CEF). After varying length of co-cultivation of both types of cells myeloblasts morphologically transformed into small fibroblast-like cells. This fibroblastoid transformation was also observed after co-cultivation of myeloblasts with CEF x-irradiated with 12,000 R. The phenomenon was further analyzed using karyologic and cytochemical criteria. Male myeloblasts were added to irradiated female CEF. The irradiated CEF disappeared after a certain time of co-cultivation and the cultures microscopically containing only fibroblast-like cells were karyologically examined. It was found that fibroblast-like cells have the male karyotype, i.e., they arose by transformation of myeloblasts and

not of irradiated CEF. Cytochemically, a quantitative difference was observed in activity of lacticodehydrogenase (LDH) and adenosintriphosphatase (ATP-ase) between CEF and myeloblasts. While the activity of LDH and ATP-ase was high in both myeloblasts and fibroblast-like cells occurring by transformation of myeloblasts, this activity was almost entirely absent in CEF. Thus the fibroblast-like cells retained some of the enzymatic properties of the myeloblasts, at least at a certain period after transformation. (auth)

6583 RADIOIMMUNOLOGICAL TESTS IN ACUTE RADIATION SICKNESS EXPERIMENTALLY INDUCED IN DOGS. Plauchithiu, Ion (Hopital de Rayon pour Adultes, Lugoj, Rumania). J. Radiol., Electrol., Med. Nucl., 46: 161-6(Mar.-Apr. 1965). (In French).

Some radiation protection measures in experimentally induced radiation sickness in dogs were tested. A total of 36 dogs was used, 18 for tests on modification of the course of radiation sickness by blood transfusions and antibiotics. These results showed improvement in restoration of hematologic parameters, and septicemic symptoms. Death of the animals in a severe state of malnutrition occurred. From the other animals, irradiated with lethal doses but given no treatment, plasma proteins were removed after eight to nine days, at the height of radiation sickness. These proteins were then injected into a healthy dog. This animal immediately showed slight signs of radiation sickness: arterial hypotension, anemia, leukopenia, modifications of bone marrow, and changes in serum protein levels. Control animals, receiving normal blood, showed no such signs. After 21 to 45 days the recipient animal showed no signs of radiation sickness. Three groups of healthy dogs were given acute doses of teleroentgentherapy in one treatment. Group 1 (four dogs) received 650 R, group 2 (eight dogs) received 850 R, group 3 (six dogs) received 1000 R (at 180 KV) over a period of 21 to 60 days. In the group irradiated with 650 R, the dog irradiated the 40th day after protein injection survived 550 days and the one irradiated the 21st day survived 432 days. In group 2 (receiving 850 R) there were two survivors: one irradiated the 63rd day after administration of proteins survived 507 and the other irradiated the 21st day survived 139 days. Group 3 irradiated with 1000 R had one survivor after 383 days (it was irradiated 21 days after treatment). It was concluded that survival depended not only on doses of irradiation and on quantity of protein administered, but also on the metabolic state at the time of irradiation. (BBB)

6584 COMPARATIVE MORPHOLOGICAL AND FUNCTIONAL (ERG) STUDIES ON THE RETINA OF THE RABBIT AFTER IRRADIATION WITH GAMMA RAYS (^{60}Co) AND HIGH-ENERGY ELECTRONS. Lommatzsch, P.; Fuerst, G.; Ulrich, W. D. (Humboldt-Univ., Berlin). Arch. Klin. Exp. Ophthalmol., 175: 34-45(Apr. 1968). (In German).

Morphological and functional changes found in the rabbit eye after irradiation with two types of radiation were compared. The first radiogenic damage was detected by the electroretinogram (ERG) and by histological examinations after a dose of 5000 R. The most radiosensitive parts of the retina were the outer and inner segments of the rods, and next the outer nuclear layer. Pyknosis of the bipolar ganglion cells of the inner nuclear layer was found after 6000 to 8000 R. The large ganglion cells did not show any morphological injury after 10,000 R. It was assumed that dead receptor cells disappeared after autolysis, but no sign of phagocytosis was seen. There was no evidence of any significant difference between the effect of 8.5-MeV electrons and ^{60}Co γ rays. After electron irradiation with 8000 R the ERG was abolished in all instances while 10,000 R of γ rays were required to produce the same effect. However, this factor alone does not seem sufficient to characterize the RBE of the two types of radiation. (BBB)

6585 MORPHOLOGICAL CHANGES IN THE NERVOUS SYSTEM CAUSED BY IONIZING RADIATION. Aszalos, Zoltan. Honvedorvos, 20: 174-8(Apr.-June 1968). (In Hungarian).

Whole-head irradiation of 42 cat brains with 50, 100, 200, 1000, and 3000 R of ionizing radiation was performed and the morphological changes caused by the radiation were determined. Examinations were made at the acute stage (one day to six wks), the intermediate stage (six wks to five months), and the late stage (five to 24 months). The findings were described and tabulated. It was considered that the morphological changes typical of damage resulting from ionizing radiation are likely to cause pathogenetic effects. It was noted that there were autoallergic effects and instances of primary radiation sensitivity in the neural tissues. Autoallergic effects were more predominant in the late stage. Damages of the ectodermal tissue were typical in the acute stage. (JPRS)

6586 FACTORS INFLUENCING HEMATOPOIETIC SPLEEN COLONY FORMATION IN IRRADIATED MICE. V. EFFECT OF FOREIGN PLASMA UPON COLONY-FORMING CELL KINETICS. Boggs, D. R.; Marsh, J. C.; Chervenick, P. A.; Cartwright, G. E.; Wintrobe, M. M. (Univ. of Utah, Salt Lake City). J. Cell. Physiol., 71: 227-38(June 1968).

Two methods were used to study repopulation of irradiated spleen by hematopoietic cells. In the first, or endogenous method, mice were given whole-body ^{60}Co γ irradiation with shielding of femoral bone marrow. In the second, or transplant method, mice were subjected to a dose of whole-body irradiation that killed virtually all endogenous colony-forming cells. Suspensions of normal cells were then injected intravenously. Results showed that foreign plasma injection induced a profound and complex change in the size and location of the colony-forming unit (CFU) cell compartment. Injection of foreign plasma before irradiation induced an increase in CFU cells as judged by endogenous colonies as well as by a modification of the endogenous method that excludes spleen colony formation from in situ spleen cells. However, the enlargement does not take place in the most populous CFU cell areas, the spleen and marrow. The concentration and total number of CFU cells in spleen and marrow were not increased by plasma injection whether judged by the number of transplantable cells or by the number of migrating endogenous cells. (BBB)

6587 EXPERIMENTAL INFECTION OF IRRADIATED WHITE MICE AND GUINEA PIGS WITH THE WESTERN-TYPE OF NORTH AMERICAN EQUINE ENCEPHALOMYELITIS (WEE). Danes, L. (Military Inst. of Hygiene, Epidemiology, and Microbiology, Prague). J. Hyg. Epidmiol. Microbiol. Immunol., 12: 37-46(1968). (In Czech).

Two strains of the Western-type virus of North America equine encephalomyelitis were used for experimental infection of mice and guinea pigs. The susceptibility and sensitivity of non-irradiated and irradiated animals were compared, using different doses of x rays. The animals were infected by intracerebral and subcutaneous route and by an aerosol inhalation. No influence of irradiation on intracerebral infection could be detected. Under certain experimental conditions, increased sensitivity to subcutaneous infection was detected in the irradiated animals. The titres of virus in the blood and brain were higher in the irradiated animals than in the non-irradiated ones. A significantly higher multiplication rate of the virus was observed in the organs of irradiated guinea pigs after infection by inhalation of the virus. The influence of irradiation on the course of virus infection is discussed in relation to the pathogenetic differences of infection. (JPRS)

6588 RBE FOR SKIN TUMORS AND HAIR FOLLICLE DAMAGE IN THE RAT FOLLOWING IRRADIATION WITH ALPHA PARTICLES AND ELECTRONS. Burns, Fredric J.; Albert, Roy E.; Heimbach, Richard D. (New York Univ., N. Y.). Contract AT(30-1)-2785. Radiat. Res., 36: 225-41(1968).

Rat skin was irradiated with cyclotron-accelerated α particles with doses ranging from 210 rads to 6850 rads and monoenergetic electrons with doses ranging from 810 rads to 12,300 rads. The beams were modified so that the depth-dose curves were approximately identical with penetrations of about 1.0 mm. Tumors were counted every four wks for 80 wks, and at death or sacrifice the hair follicle damage was assessed by using whole mounts of separated epithelium. The RBE values determined from a comparison of the dose response curves were: acute skin injury, RBE = 3.0 ± 1.0; hair follicle survival, RBE = 2.1 ± 0.7; hair follicle damage, RBE = 2.6 ± 0.4; tumor induction, RBE = 2.9 ± 0.5. Within the experimental error, these values were independent of the dose. For both types of radiation, the tumor incidence increased approximately as the square of time and at low doses approximately as the 4th power of dose. The histological characteristics of the tumors and the correlation between the incidence of tumors and damaged hair follicles were independent of the type of radiation. The results were consistent with the hypothesis that structural damage to the hair follicles is a factor in the tumor induction process. (auth)

6589 RBE OF 2.2-GeV PROTONS FOR 30-DAY LETHALITY IN MICE. Jesseph, J. E.; Moore, W. H.; Straub, R. F.; Tisljarlentulis, G. M.; Bond, V. P. (Brookhaven National Lab., Upton, N. Y.). Radiat. Res., 36: 242-53(1968).

BNL Swiss Albino mice were exposed (five in tandem) in a 2.5-cm I.D. Lucite tube to a parallel beam of 2.2-BeV protons. The LD_{50} was $1.81 \pm 0.03 \times 10^{10}$ p/cm^2, or 641 rads. The corresponding LD_{50} for 250-kVp x-rays was 557 rads, yielding an RBE of 0.87. No difference in time pattern of death was observed between the x-irradiated and proton-irradiated animals. It is concluded that, with the exposure geometry used in these experiments, ionization by primary and high-energy secondary protons was the major dose constituent. A comparison is made with other experiments on the lethal effects of protons in which different

geometries were employed. There is evidence that, with exposure in material of larger diameter in which there is a larger contribution to dose from lateral scatter, high-LET components of the beam may play a more dominant role. It was also observed in these experiments that the presence of Pseudomonas aeruginosa may result in a lower LD_{50} and "early death," following either x irradiation or proton radiation. This may have accounted for some of the early deaths following proton irradiation reported earlier. (auth)

6590 MICROVILLAR BLEB FORMATION IN PRIMATE HEPATOCYTES IRRADIATED WITH 32-MeV PROTONS. Ghidoni, J. J.; Thomas, H. (Baylor Univ., Houston, Tex.). Radiat. Res., 36: 327-32(1968).

Eight rhesus monkeys (Macaca mulatta) were whole-body irradiated with 6000 rads of 32-MeV protons. Animals were killed at several time intervals after exposure. Tissue blocks were fixed in glutaraldehyde, postosmicated, and then embedded in Maraglas-D.E.R. 732 resin. Observation of ultrathin sections by electron microscopy revealed balloon-like enlargements of distal portions of hepatocytic microvilli (blebs) which were less dense than the proximal portion of microvilli. The blebs ranged widely in size; some were contained within the space of Disse, whereas many protruded into the sinusoidal lumen. In a few micrographs the sinusoidal lumen was filled with bleb-like structures. Such bleb formation suggests a possible mechanistic explanation for hepatic congestion following high levels of irradiation. (auth)

6591 RESPONSE OF THE SKIN OF SWINE TO INCREASING SINGLE EXPOSURES OF 250-KVp X-RAYS. Archambeau, J. O.; Mathieu, G. R.; Brenneis, H. J.; Thompson, K. H.; Fairchild, R. G. (Brookhaven National Lab., Upton, N. Y.). Radiat. Res., 36: 299-326(1968).

When the skin of the shoulder (A field) and lower back (C field) is irradiated through 10-cm-diameter fields with 250-kVp x rays, having a HVL of 0.87 mm copper, a dose range is reached between approximately 1600 rads and 3000 rads in which a moist reaction is or is not formed. If a moist reaction is formed, it either heals completely, partially, or not at all. The evolution, time course, and dose dependence of the moist reaction that occurs following irradiation has been determined. The moist reaction is found at 17.5 ± 0.6 days in the A field, and 20.8 ± 0.8 days in the C field. The reaction evolves to involve from 5% to 100% of the field by 24.9 ± 0.5 days in the A field and by 28.5 ± 1.0 days in the C field. Healing is complete by 36.0 ± 1.0 days in the A field and by 38.0 ± 1.3 days in the C field. The area of the field involved with a moist reaction at the time of maximal involvement is dose-dependent. The area of the field involved with a moist reaction at the time of complete healing is also dose-dependent. The dose at which 50% of the fields was not healed was 2273 ± 103 rads in the A field, 2578 ± 141 rads in the C fields, and 2437 ± 89 rads in the A and C fields. The values in the C field are significantly different from those in the A field except for the dose at which 50% of the fields was not healed and the time at which the field was maximally healed. (auth)

6592 SURVIVAL STUDIES ON RODENTS EXPOSED TO REACTOR FAST NEUTRON RADIATION. Gambino, Jerome J.; Faulkenberry, B. H.; Sunde, Paul B. (Northrop Corp. Labs., Hawthorne, Calif.). Radiat. Res., 35: 668-80(1968).

A Triga Mark-F reactor was used to provide exposures in a series of experiments designed to compare the response of pocket mice and Swiss-Webster mice to fast neutrons. The $LD_{50(30)}$ values and 95% confidence intervals for pocket mice and Swiss-Webster mice exposed to fast neutrons are: Perognathus longimembris, 470 (445 to 498) rads; P. formosus, 340 (328 to 353) rads; Swiss-Webster mice 275 (256 to 295) rads. The $LD_{50(30)}$ values for cobalt-60 γ irradiation of the same three species are: 1450 (1390 to 1510) rads, 1080 (1014 to 1150) rads, and 740 (665 to 825) rads, respectively. All values are given as midline body doses. Results indicate that pocket mice are resistant to the lethal effects of fast neutron exposure, as well as to x and γ radiation. The absence of an increased relative effectiveness of fast neutrons to produce 30-day deaths in pocket mice suggests that their resistance to ionizing radiation cannot be attributed to generalized or local hypoxia in radiocritical tissues. Rather, results tend to corroborate the earlier suggestion that radiation resistance in Perognathus may be explicable on the basis of peculiar cytokinetics of steady-state populations. (auth)

6593 DECIDUOMA INDUCTION IN THE RAT BY X-IRRADIATION. Galassi, L.; Schepis, P. J. (Tufts Univ., Boston). Experientia, 24: 943-4(Sept. 15, 1968).

Rats were given 500 to 1000 R of x radiation on the fifth day of pseudopregnancy; the right side of the abdomen was shielded so that only the left uterine horn was irradiated. Four days later deciduomata were found in the left horn, and in one animal a deciduoma was also present in the right horn. Histological examination of the deciduomata revealed normal decidual cells and autoradiographic analyses indicated that endometrial substances were transformed into decidual cells. Factors responsible for the formation of radioinduced deciduomata are discussed. (H.L.W.)

6594 STERILIZATION OF THE LEFT OVARY OF CHICKEN AND QUAIL BY THE ACTION OF THYMIDINE-^{3}H DURING OVOGENESIS. Callebaut, M. (Studiecentrum voor Kernenergie, Mol, Belg.). Experientia, 24: 944-5(Sept. 15, 1968). (In French).

After nine days of incubation chicken eggs were opened and tritium-labeled thymidine was deposited on the internal membrane. This procedure was repeated eight times at intervals of eight to nine hrs. After 14 days of incubation two ovaries were fixed and at hatching two others were fixed. Eggs of quails were treated in a similar way. Hatching and development were not significantly influenced by the treatment. However, nearly all of the germinal cells disappeared after 14 days of incubation and the ovaries of chickens and quails were completely sterilized by the time of hatching. (H.L.W.)

6595 EFFECT OF HIGH ENERGY X-IRRADIATION OF THE HEAD ON CEREBRAL BLOOD FLOW AND BLOOD PRESSURE IN THE MACACA MULATTA. Chapman, Paul H.; Young, Robert J. Aerosp. Med., 39: 1316-21(Dec. 1968).

Whole-body supralethal doses of radiation produce a significant decrease in blood pressure and cerebral blood flow within minutes following irradiation. Nine Macaca mulatta monkeys were exposed to a head only dose of 2,500 rads of 6 MeV x-radiation at a dose rate of 644 R/min. Five animals served as sham-irradiated controls. Cerebral blood flow, blood pressure, and systemic arterial and cerebral venous blood gas measurements were made just prior to and during the hr following irradiation. Cerebral blood flow was calculated from desaturation curves using the inert radioactive isotope ^{85}Kr. A small but significant decline in blood pressure was found immediately after irradiation with no significant change in cerebral blood flow. It was concluded that the hypotension and decreased cerebral blood flow observed after whole-body radiation exposure are not caused primarily by a direct effect of radiation on the central nervous system. (auth)

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Refer also to abstracts 6345, 6397, 6429, 6430, 6454, 6458, 6471, 6473–6475, 6480, 6486, 6504, 6508–6510, 6517, 6525–6544, and 6549.

6596 (AERE-R-5766) BLOOD COUNTS ON RADIATION, NON-RADIATION AND NEW-ENTRY EMPLOYEES. RESEARCH ESTABLISHMENT U.K.A.E.A. HARWELL. Sanders, C.; Orr, R. G.; Evans, R. J. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1968. 24p. Dep. CFSTI. UK 3s. 6d.

The blood count results on a sample of male and female, radiation and non-radiation workers in 1962, and on all new-entrants of both sexes who presented themselves for the pre-employment medical examination from November 1965 to November 1966 are given. The data were analyzed according to sex, age groups, and radiation category for the 1962 sample, and according to sex only for the pre-employment blood counts. The youngest age groups of the males for both radiation categories showed the highest incidence of neutropenia. Consideration was given to the range of normal values, and while it appears that the present Harwell standard ranges are in reasonable agreement with those quoted in the literature and text books, it is found that the 95% ranges for the total leucocyte, neutrophil, lymphocyte, and monocyte counts are wider. It is suggested that the range of these latter components for the total and differential leucocyte counts could be extended, and that the adoption of such revised ranges would reduce the number of repeat blood counts. (auth) (UK)

6597 (JPRS-44299) SPACE BIOLOGY AND MEDICINE. VOL. 1, NO. 5, 1967. Translation of Kosm. Biol. Med., 1: No. 5, 1-96(1967). 144p. CFSTI.

Eighteen papers are included that discuss developments in Soviet space biology and medicine. A separate abstract was prepared on one paper. (C.H.)

For an abstract of the individual paper see: 6567.

6598 (N-68-25382) PUBLIC HEALTH ASPECTS OF GALACTIC RADIATION EXPOSURE IN SUPERSONIC TRANSPORT. Schaefer, Hermann J. (Naval Aerospace Medical Inst., Pensacola, Fla.). Mar. 19, 1968. 13p. (NASA-CR-94760; NAMI-1033). CFSTI.

The prospect of large-scale commercial passenger trans-

portation at SST altitudes in the lower stratosphere calls for an accurate assessment of the galactic radiation exposure. Highest radiation levels prevail at high latitudes (polar region) and solar minimum and reach about 1 millirem/hour at 65,000 feet. The accumulated dose of 0.6 rem/year which an SST crew member spending 600 hours/year at altitude would receive exceeds the Maximum Permissible Dose (MPD) for members of the public and would classify crew members as radiation workers in terms of official recommendations. The assumption of 50 SST each exposing 200 passengers to 1000 hours/year at SST altitude would lead to a population dose about equal to the contribution from industrial radiation workers, with both exposures ranking well below the two largest man-made additions to the natural background, medical use of x rays, and fallout. The heavy flux is attenuated to 3 percent or less at 65,000 feet, depending on the nuclear species, yet, only 0.1 percent of this residual flux accounts for maximum ionization hits. That means the microbeam hazard of heavy nuclei is insignificant at SST altitudes. (auth)

6599 A STUDY OF HEMATOLOGICAL COMPLICATIONS OCCURRING IN PATIENTS WITH POLYCYTHEMIA VERA TREATED WITH ^{32}P (BASED ON A SERIES OF 296 PATIENTS). Tubiana, M.; Flamant, R.; Attie, E.; Hayat, M. (Inst. Gustave Roussy, Villejuif, France). Blood, 32: 536-48(Oct. 1968).

Three hundred three patients with polycythemia vera were treated with ^{32}P more than five years ago. Seven patients were excluded because they were treated by ^{32}P elsewhere before their first visit. Of the 296 other patients, 269 were followed up regularly for more than five years. The median survival after hematologic diagnosis was 14.5 years. It was shorter in older patients and in those patients who had the shortest remissions after the initial ^{32}P treatment. Of 145 patients who had died, death was due in 53 cases to hematologic complications (29 acute leukemia, 4 chronic leukemia, 16 myeloid metaplasia or myelofibrosis, 4 aplastic anemia). The latter complications were seen most commonly in those patients who received the highest total dose of ^{32}P, those with a high initial white count, and those in whom the spleen was palpable at least 2 cm. beneath the costal margin. The influence of the quantity of ^{32}P given was significant for equivalent clinical situations, the influence of white cell count and spleen size was significant for equal doses of ^{32}P. This suggested that these two types of factors favor the early occurrence of hematologic complications. (auth)

6600 TISSUE TOLERANCE: CENTRAL NERVOUS SYSTEM. Verity, Gordon L. Radiology, 91: 1221-5(Dec. 1968).

Precise limits of central nervous system tissue radiation tolerance are not known, although ranges of tolerance were fairly well established. Experience has shown that the incidence of clinically identifiable damage is low as long as the dose rate is kept around 900 rads/week in four to six fractions and the total dose does not exceed the approximate level of 6,000 rads. Variations from this time-dose-fraction relationship as well as some other factors may cause a rise in the risk of irreversible damage. (auth)

6601 EFFECTS OF IONIZING RADIATION IN THE HUMAN ORAL CAVITY AND OROPHARYNX. RESULTS OF A SURVEY. King, E. Richard; Elzay, Richard P.; Dettman, Prentiss M. (Medical Coll. of Virginia, Richmond). Radiology, 91: 1001-7; 990(Nov. 1968).

The result of a survey on the effects of radiation therapy on the normal tissues and structures of the oropharynx is reported. A selected group of therapeutic radiologists and prosthodontists was questioned. It is apparent that many members of the dental profession, who are involved in the management of patients with oropharyngeal cancer treated with radiation, are not conversant with many of the undesirable reactions that result from such treatment. Also, therapeutic radiologists, as a group, are not familiar with the role that prostheses play in the incidence of osteoradionecrosis, at least according to the prosthodontists. These facts demonstrate a need for better communication between the two groups. The survey did display, however, many areas of agreement within each group separately as well as between the two. (auth)

6602 LIMITS OF HUMAN TOLERANCE TO LOCAL INFRARED IRRADIATION. Dedenko, I. I.; Gnoevaia, N. K.; Ivanov, V. S. Kosm. Biol. Med., 2: 73-7(May-June 1968). (In Russian).

Attempts to establish quantitative indices of human tolerance to IR irradiation were made. The intensity of the irradiation was taken into account. The body areas exposed in these experiments were the forearms of the test subjects. A total of 169 tests were made on sixteen test subjects. As soon as the test subjects felt an intolerable pain, the experimentation was stopped. In some experiments, up to 210 cm^2 of the surface of the skin was exposed. The results are summarized in table form. It was found that the pain threshold does not depend on the absolute value of the skin temperature, but on the rate of its increase. The higher the irradiation intensity becomes, the lower is the absolute temperature at which a feeling of intolerable pain appears. (IAA)

6603 CHANGES IN THE REACTIVITY OF THE AUTONOMIC NERVOUS SYSTEM IN CHILDREN AT LATE PERIODS AFTER RADIOTHERAPY. Kuliabko, O. M.; Mirimova, T. D. (Academy of Medical Science, Moscow). Sov. Med., 29: 60-5(Apr. 1966). (In Russian).

Reactivity of the autonomic nervous system was studied in children at long intervals after x-ray therapy. The phagocytic index was evaluated in 50 patients ranging in age from 2½ to 21 yr who received radiotherapy for hemangiomas and malignant tumors. Radiation doses ranged from 800 to 30,000 R. In 35 out of 50 patients irradiated at an early age, depression of the phagocytic activity of leukocytes occurred, when tested after administration of a neurotropic drug, pilocarpine. This was similar to the change seen in nonirradiated patients with malignant tumors and in children with leukemia. (BBB)

6604 ANALYSIS OF STATE OF HEALTH OF WORKERS IN CHEMICAL INDUSTRIES PRODUCING PRODUCTS MADE OF SYNTHETIC MATERIAL. Bugaiska, J.; Kownasowa, T.; Stachurska, I. (Wojewodzkiej Przychodni Przemyslowej, Wroclaw). Przegl. Lek., 23: 745-50(Oct. 1967). (In Polish).

The effects of high-frequency (27 Mcps) electromagnetic radiation was studied at the Provincial Outpatient Clinic for Industrial Occupational Diseases that examined the workers at a small chemical establishment producing plastic products made of Bakelite, polyethylene, polyvinyl chloride, and polystyrene. Analysis of the results of the examinations was made in terms of the design of the establishment and differences in production engineering and the occupational dangers that result therefrom. The predominating symptoms in all the three examined groups were changes in the peripheral blood: anemia and reduced number of blood platelets. Results of the hematological studies were treated statistically. Special attention was paid to 22 women, employed in the electric welding of polyethylene and polyvinyl chloride foils. Those persons were directly exposed to the operation of the high-frequency electromagnetic field at 800-W intensity. The hematologic changes that were found in this group coexisted with symptoms previously described as characteristic for persons exposed to the operation of a high-frequency electromagnetic field. Of these 22 persons, 15, or 68%, had hemoglobin levels below 75%, 41% erythrocyte counts below 3,800,000 per mm^3, 10% leukocyte counts below 5000 per mm^3, platelet counts below 180,000 per mm^3, and 41% with serum albumin levels below 55% of total serum proteins. The possibility that microwave radiation can impair protein- and blood cell-forming enzyme systems is suggested. (BBB)

6605 RADIODERMATITIS CAUSED BY A RADIOACTIVE GOLD RING. Leone, Richard A. (Olean Medical Group, N. Y.). J. Amer. Med. Ass., 206: 2113-14(Nov. 25, 1968).

A radioactive gold ring made from improperly salvaged gold radon seeds caused dermatitis which has lasted for over 40 years. The source of the radiation was lead 210, a beta emitter with a half-life of 22 years. (auth)

6606 ZAKLADY NUKLEARNI MEDICINY. (Bases of Nuclear Medicine). Dienstbier, Zdenek; Andrysek, Oskar. Prague, Statni Zdravotnicke Nakladatelstvi, 1963. 216p.

This book contains chapters on: fundamental radiation biology, including some physical constants; physiological changes due to irradiation, e.g., in blood and genetic (DNA) systems; the clinical picture of radiation effects; problems encountered in civilian protection when nuclear weapons are used; useful applications of radioisotopes and safety precautions to be observed in such use; and use of radioisotopes in medicine for therapy and for diagnosis, including some of the short-lived isotopes and their preparation onsite from a generator. The treatment is technical but rather basic. (29 references). (TTT)

Radiation Effects on Plants

Refer also to abstracts 6340, 6353, 6357, 6391, 6395, 6398, 6403, 6404, 6410, 6413–6418, 6425, 6426, and 6428.

6607 NUCLEAR METABOLISM OF BARLEY IN ONTOGENESIS UNDER NORMAL CONDITIONS AND AFTER γ-RAY IRRADIATION. Chopyak, A. M.; Budnitskaya, E. V.; Stoletov, V. N. (Inst. of Biochemistry, Moscow. Moscow State Univ.). Biochemistry (USSR) (Engl. Transl.).

Translated from Biokhimiya, 33: 34-42(Jan.-Feb., 1968).

Parallel increases took place in the contents of DNA, RNA, protein, and phosphorus γ-containing compounds of the acid-

soluble fraction (ASP) during ontogenesis of unirradiated barley. After γ irradiation of the reproductive organs the biosynthesis of DNA and RNA outstripped protein biosynthesis. The content of DNA and RNA in the embryos, shoots, plants, and ears of barley grown from irradiated seeds was modified and reached the level characteristic of plants grown from unirradiated seeds only when the seeds were fully ripe. Vernalization of irradiated seeds led to more considerable disturbances of nucleic acid metabolism in ontogenesis, and these were not always repaired on full ripening of the seeds. Under the influence of irradiation of the seeds, the link between biosynthesis of nucleic acids and of ASP in barley ontogenesis was broken. Vernalization of the irradiated seeds led to irreversible disturbances of the link between the biosynthesis of nucleic acids and protein. (auth)

6608 RADIOSENSITIVITY OF POTATOES TO GAMMA- AND PROTON IRRADIATION APPLIED TO TUBERS AND EYES BEFORE PLANTING. Shaidorov, Yu. I.; Gertsuskii, D. F.; Skukina, I. S.; Alekseenko, L. V.; Nikitina, I. V. Kosm. Biol. Med., 2: No. 5, 14-19(Sept.-Oct. 1968). (In Russian).

The effect of pre-planting irradiation of potato tubers and eyes (isolated with a small endosperm portion) with ^{60}Co γ-rays and 620 MeV protons on the plant growth and development was studied. The effect of irradiation on the eyes was shown to be less than that of tubers and the inhibitory effect of proton radiation was higher when compared to that of γ-rays. (auth)

6609 CHANGES OF THE RADIATION EFFECT IN PLANTS EXPOSED TO SPACE FLIGHT FACTORS. Gertsuskii, D. F.; Nikitina, I. V.; Alekseenko, L. V.; Skukina, I. S. Kosm. Biol. Med., 2: No. 5, 12-14(Sept.-Oct. 1968). (In Russian).

Data are presented that indicate changes of the ascorbic acid content in onion sets induced by preplanting γ irradiation of bulbs or by space flight effects. An exposure of plants to low doses of γ radiation and space flight factors applied separately, resulted in an increase of the vitamin C content in the top of onion. In the case of the cumulative effect of these stress-agents space flight factors diminished the stimulating effect of radiation, reducing the ascorbic acid content. (auth)

6610 RADIOSENSITIVITY AND THE OXYGEN EFFECT MEASURED AT DIFFERENT PHASES OF THE MITOTIC CYCLE USING SYNCHRONOUSLY DIVIDING CELLS OF THE ROOT MERISTEM OF VICIA FABA. Hall, Eric J.; Brown, J. Martin; Cavanagh, Josephine (Churchill Hospital, Oxford). Radiat. Res., 35: 622-34(1968).

Vicia seedlings were immersed in a solution of hydroxyurea for a period of 24 hrs. The meristematic cells were partially synchronized by this treatment; 11 hours after removal from the hydroxyurea, 40% of the cells were in mitosis. Seedlings were exposed to x rays at various times after removal from hydroxyurea, that is, with the meristematic cells at different phases of their mitotic cycle. Radiosensitivity was assessed in terms of growth inhibition of the primary root and was found to vary widely through the cell cycle, reaching a maximum when most meristematic cells were in mitosis. Irradiations were carried out under aerated and hypoxic conditions; it was found that the oxygen enhancement ratio did not change significantly with phase of the mitotic cycle. (auth)

6611 ENHANCEMENT OF UV SENSITIVITY OF YEAST IN FROZEN STATE. Hieda, Kotaro (Rikkyo Univ., Tokyo); Ito, Takashi. Mutat. Res., 6: 325-7(Sept.-Oct. 1968).

Two diploid strains of Saccharomyces cerevisae, one with normal uv-radiosensitivity and one with enhanced uv-radiosensitivity and a reduced dark-repair system, were irradiated in the frozen state. After uv-irradiation at –79°C, –196°C, and room temperature dose-survival assays were made both before and after exposure to visible light. Both strains irradiated at the lower temperatures were more uv-sensitive than those irradiated at room temperature. Both strains exhibited less photoreactivability when irradiated in the frozen state (–196°C) than in the liquid state (room temperature). It was concluded that photoproducts other than a cyclobutane-type pyrimidine dimer were predominantly formed in the frozen state and constituted a major cause of the biological damage. (M.M.B.)

6612 EFFECT OF GAMMA RADIATIONS ON PROTEIN AND OIL CONTENT IN SOYBEAN SEEDS. Corbean, S.; Bajescu, N. An. Inst. Cercet. Pentru Cereale Plante Teh.-Fundulea, 33: 281-92(1965). (In Rumanian).

The effect of γ radiation on the chemical composition of soybean seeds was investigated in field experiments. It was found that γ radiation affected particularly the crop on a poorly fertilized soil, bringing about a change in the protein/oil ratio. Low γ radiation doses induced a protein increase whereas high doses raised the oil percentage. On fertilized soil, the protein and oil content did not vary with the irradiation dose, but altered only with different fertilization rates. A high protein content became obvious at doses of 150 R and 300 R in plants grown on soil fertilized with 1,500 kg NH_4NO_3, 4,000 kg superphosphate and eight tons barnyard manure per hectare. (Rom. Sci. Abstr.)

6613 STUDY ON WINTER BARLEY VARIETIES DURING IRRADIATION. Grinvald, C.; Diaconu, P.; Banu, M. An. Inst. Cercet. Pentru Cereale Plante Teh.-Fundulea, 33: 135-44(1965). (In Rumanian).

The behavior of 10 winter barley lines and varieties, irradiated with thermal neutrons and x rays was studied under field conditions during 1965. Results are presented for the Cenad 345 variety, and the 339/60 and 34/63 lines. The irradiation induced a decrease of emergence and survival percentage, lowered the number of fertile tillers, of spikelets on the ear, internodes, and holm length. Plant fertility decreased considerably in M_1 as compared to the nonirradiated control. Fertility percentage gradually fell with dose increase. The detrimental effect of thermal neutrons was even greater than that of x rays as emphasized in all the investigated characters, in the number of chromosomal aberrations of the reductional division, and in the M_1 ear-fertility. (Rom. Sci. Abstr.)

6614 EFFECT OF LONG-WAVE AND SHORT-WAVE ULTRAVIOLET RADIATION ON THE GROWTH AND DEVELOPMENT OF TOMATOES AND CUCUMBERS IN GREENHOUSE. Selga, M. P. pp 157-65 of Tautsaimnieciba Derigie Augi. IV. Zunde, I.; Jakovieva, N.; Melehina, A.; Rupais, A. (eds.) Riga, Izdevnieciba Zinatne, 1968. (In Latvian).

Ultraviolet radiation, applied to plant organism, produces long-term and short-term effects which decrease with the intensity of the sunlight. Long-wave ultraviolet radiation (in the range from 280 to 420 mμ) stimulated the development of the plants of cucumbers and tomatoes. Tomatoes bore fruit significantly earlier and cucumbers produced more fruit. Short-wave ultraviolet radiation inhibited the growth of the plants. (tr-auth)

6615 INVESTIGATIONS ON THE RELATIONS BETWEEN THE BIOLOGICAL EFFECTS OF IONIZING RADIATION AND MAGNETISM. PART 2. JOINT EFFECT OF IONIZING RADIATION AND MAGNETISM ON THE GROWTH OF THE ROOT OF VICIA FABA. Santha, Andras. Honvedorvos, 20: 198-205 (Apr.-June 1968). (In Hungarian).

Pregerminated seeds of Vicia faba were exposed for 72 hr to a homogeneous, permanent magnetic field of 3000 Oe strength. This exposure considerably increased the growth rate. Simultaneous 200 to 600 R X ray or ^{60}Co γ irradiation had an opposite effect. The relations between these effects were investigated. (JPRS)

6616 AMITOSIS AND BINUCLEATE CELLS OF COTTON EXPOSED TO IRRADIATION AND ELECTRICAL IMPULSES. Agaev, Yu. M.; Rakhmanova, R. A. (Inst. of Genetics and Plant Breeding, Baku). Dokl. Akad. Nauk, Azerb. SSR, 22: No. 11, 61-5(1966). (In Russian).

Cotton seeds of two varieties received 500, 1000, 10,000, and 20,000 R of ^{60}Co γ rays at a 70-R/min dose rate. Some of the irradiated seeds were also exposed to 2400-V electrical impulses of 15-, 30-, and 60-sec duration. After the seeds had germinated in Petri dishes, the rootlets of the cotton seedlings were fixed, stained, and examined cytologically. Cytoanalysis of rootlets revealed the presence of numerous abnormalities in mitotic processes and also in interphase cells. Both types of disorders were intensified with increased doses of radiation. In addition to disorders of mitosis, frequent changes of nuclei resulting from amitosis caused the appearance of binucleate cells. The study failed to detect among binucleate cells any further division into three-nuclei forms. The presence of micronuclei did not inhibit the mitotic division of primary nucleus. Micronuclei created by amitosis resembled the product of mitosis with all its stages blocked or changed beyond recognition. (BBB)

6617 COMPARISON OF THE EFFECTS OF RADIATION ON THE CELL MEMBRANE AND ON THE REPRODUCTIVE SURVIVAL OF YEAST. Myers, D. K.; Karazin, Tamara (Chalk River Nuclear Labs., Ont.). Radiat. Res., 35: 612-21(1968).

Haploid and diploid yeast cells harvested from growing and stationary-phase cultures were x irradiated in the presence and in the absence of iodoacetamide as a radiosensitizing agent. There was no correlation between the subsequent loss of intracellular potassium ion and the loss of ability to form visible colonies under these conditions. In addition, there was no correlation between these parameters when the effects of uv irradiation on five strains of yeast, including two uv-sensitive mutants, were measured. It was concluded that the loss of reproductive survival in irradiated yeast cells could not be attributed to the kind of membrane damage that results in potassium leakage from these cells. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 6367, 6401, 6409, 6412, 6415, 6419, 6420, 6422, 6427, 6470, 6472, 6562, 6625, and 6626.

6618 LOSS OF PHOTOREACTIVITY OF UV-IRRADIATED LYSOGENS OF HCR$^+$ AND HCR$^-$ CELLS. Scherneck, S.; Theile, M.; Geissler, E. (Univ., Rostock, Ger.). Photochem. Photobiol., 8: 69-71(July 1968). (In German).

The uv-induced loss of photoreactivity observed previously in Pseudomonas aeruginosa is also observable in Escherichia coli K 12S hcr$^+$ (λ), cultivated in saline solution. In E. coli K 12S hcr$^-$ (λ) cells under the same culture conditions, the capacity for photoreactivation also decreases after a period of time. The period of constant reactivation capacity of 36 min is, however, more than twice as long as in the corresponding hcr$^+$ strain capable of dark repair. (J.S.R.)

6619 EFFECT OF HELPER PHAGES AND/OR MULTIPLICITY OF INFECTION ON THE REPAIR OF ULTRAVIOLET DAMAGES IN T4. Barricelli, Nils Aall; Metcalfe, Ralph (Univ. of Washington, Seattle). Virology, 36: 476-89(Nov. 1968).

The problem raised by the ultraviolet (UV)-target sizes of T4 cistrons determined by the survival of phenotype (SP survival) of irradiated wild-type phage in mixed infection with unirradiated carrier was investigated. It is noted that the greatly overestimated target sizes obtained by this latter method, particularly for macrotarget functions, are comparable to the mean target size of the three vulnerable centers determined by multiplicity reactivation. A suggestion that the three vulnerable centers represent early functions required for repairing processes like V-gene reactivation, X-gene reactivation, and possibly other similar processes hereafter collectively designated as spontaneous reactivation, was used as a basis for the interpretation. The greatly overestimated SP-target sizes are assumed to be the effect of a lack of or a reduction of spontaneous reactivation, when an irradiated phage competes with unirradiated phages for phenotypic expression. (auth) (TSS)

6620 INTESTINAL FLORA IN WHOLE-BODY AND INTESTINAL X-IRRADIATED RATS. Kent, Thomas H.; Osborne, James W.; Wende, Carolee M. (Univ. of Iowa, Iowa City). Radiat. Res., 35: 635-51(1968).

Striking changes occurred in mid-small intestinal and cecal flora of rats after exposure to 1400 R of whole-body x irradiation or 2000 R of intestinal x irradiation delivered at 250 kVp and 30 mA. The changes reached a maximum three days after irradiation. A consistent 100- to 10,000-fold increase in coliforms and enterococci occurred at both sites, and similar increases in proteus occurred in most animals. The normally predominant lactobacilli decreased slightly in numbers or remained unchanged. Other organisms participated less constantly in the overgrowth. Massive bacterial invasion of the severely injured small intestinal mucosa did not occur. There was no difference in bacterial invasion of mesenteric lymph nodes, spleen, liver, or heart blood between control and irradiated animals. The bacterial overgrowth in the intestines was effectively prevented by orally administered neomycin–polymyxin B–bacitracin without altering mortality. The findings indicate that massive intestinal flora changes occur in rats with the intestinal-type irradiation syndrome, but these changes are probably not significant in causing the animal's death. (auth)

6621 EFFECT OF GAMMA IRRADIATION ON THE GROWTH RATE OF SPECIES OF BACILLUS CEREUS GROUP. Smirnoff, W. A. (Forest Research Lab., Quebec); Cantin, M. J. Invertebr. Pathol., 9: 357-63(Sept. 1967).

The rate of development of six varieties of Bacillus of the cereus group, and their degree of survival after exposure to a range of irradiation doses were tested. A source of ^{60}Co was used to administer doses of 57,070, 114,140, 228,280, 456,560, and over 500,000 rad. Growth of all six varieties was inhibited in the range 228,280 to 456,560 rad and suppressed at 500,000 rad and over. B. thuringiensus var. entomocidus was the most sensitive. Up to 500,000 rad, no modification in sporulation and crystal formation appeared; the only observable change was the time required for lysis, that increased as the dose increased. Within the intermediate range of treatment, 228,280 to 456,560 rad, var. entomocidus, dendrolimus, and sotto showed low survival; alesti and thuringiensis showed moderate survival; and only cereus had a high survival. However, development was not resumed before 24 and 72 hr for thuringiensis and cereus, respectively. The smallest irradiation dose that had an effect on the B. cereus group was 57,070 rad. (BBB)

6622 POSTIRRADIATION PERMEABILITY OF ESCHERICHIA COLI CELLS. Pollard, E. C.; Weller, Patricia K. (Pennsylvania State Univ., University Park). Contract AT(30-1)-2804. Radiat. Res., 35: 722-39(1968).

Escherichia coli cells that were subjected to γ irradiation show leakage of components. Those associated with DNA appeared in the medium with no lag. The absence of lag was observed even for cells in which the tracer label was far from the polymerase, indicating that the enzyme causing DNA degradation was probably not the polymerase. A temperature-sensitive mutant that does not synthesize DNA at temperatures above 42°C nevertheless showed leakage. The amount, but not the initial rate of leakage, was oxygen-dependent. Leakage after a lag of 40 minutes was observed in many, but not all, strains. This was general, indicating a considerable impairment of the permeability barrier. The strain dependence, temperature dependence, and lack of oxygen sensitivity suggested that the delayed permeability was associated with the induction of a defective prophage. Leakiness in all cells occurred at long times after irradiation. We suggest that this is due to a developing imbalance in enzyme content due to radiation action on transcription. (auth)

6623 RADIORESISTANCE OF MICROCOCCUS RADIODURANS DURING THE GROWTH CYCLE. Serianni, R. W.; Bruce, A. K. (State Univ. of New York, Buffalo). Radiat. Res., 36: 193-207(1968).

Micrococcus radiodurans, irradiated aerobically in phosphate buffer, exhibits a phasic response to x irradiation during its growth cycle. The culture progresses from a relatively sensitive state during the exponential portion of the growth cycle to a highly resistant state during the stationary phase. The shift in resistance is characterized by a marked extension of the shoulder of the survival curve and a threefold increase in the LD_{99} from 250 kR to over 700 kR. The resistant state appears to be a metastable condition, readily induced in exponential-phase cultures and easily reversed in stationary-phase cultures. Similar variations are not elicited in response to uv irradiation. The phasic response does not appear to be the result of a low-molecular-weight extractable sulfhydryl radioprotective agent. (auth)

6624 SOME EFFECTS OF CHRONIC IRRADIATION ON A STEADY-STATE YEAST POPULATION. Welch, G. P. (Univ. of California, Berkeley). Radiat. Res., 36: 274-86(1968).

Saccharomyces cerevisiae in continuous culture was subjected to chronic x irradiation for many generations with apparently neither progressive deterioration nor acquired resistance to radiation. Detrimental effects on morphology and growth rate were observed, however, and measurements of the latter are presented graphically. Cycling of radiation on the continuous culture did not induce synchrony. (auth)

Radiosterilization and Radiopreservation

Refer also to abstracts 6426, 6479, and 6560.

6625 (COO-1183-28) GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOTULINUM IN THE TEMPERATURE RANGE 34 TO 50 F. [Progress Report]. Segner, W. P.; Schmidt, C. F. (Continental Can Co., Inc., Chicago, Ill. Metal Div. Research and Development). Oct. 1968. Contract AT(11-1)-1183. 4p. Dep. CFSTI.

The growth characteristics of Clostridium botulinum Type E on irradiated (0.1 and 0.2 Mrad) samples of fresh haddock maintained at refrigerated storage temperatures (34 to 50°F) were studied. Samples were inoculated with various numbers of spores and assays for toxin were conducted at various times during the next 40 days. (C.H.)

6626 (MIT-3727-5) TREATMENT OF POULTRY WITH IONIZING RADIATIONS TO DESTROY SALMONELLAE. Final Report. Nickerson, J. T. R.; Licciardello, J. J.; Goldblith, S. A. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nutrition and Food Science). Nov. 1968. Contract AT(30-1)-3727. 100p. Dep. CFSTI.

The effectiveness of γ radiation for the sterilization of Salmonellae-infected poultry was investigated. Results showed that a dose of 250 krad was sufficient to kill bacteria resulting in the maximum level of contamination of chickens. Data are included on the effect of growth phase, temperature, number of organisms present, type of meat (white or dark), chicken breed, refrigerated storage, and freezing on the survival of Salmonellae in chicken meat. The selection of culture media for the growth and isolation of Salmonellae is discussed. (C.H.)

6627 (NSJ-tr-89) EFFECT OF TEMPERATURE ON RADIATION INDUCED MALE STERILITY IN THE SILKWORM,

BOMBYX MORI L. Sugai, Etsuji. Translated for Japan Atomic Energy Research Inst., Tokyo, from Nippon Oyo Dobutsu Konchugaku Zasshi, 9: 266-70(1965). 9p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The effect of environmental temperature on γ-radioinduced male sterility in the silkworm Bombyx mori was studied. Evidence was obtained that sterility induced by irradiation was influenced to a great extent by the difference of temperature after irradiation, whereas no significant effect was indicated when the temperature treatment was given before irradiation. Furthermore, it was found that the duration necessary for the effectiveness of the post-irradiation temperature to be clearly apparent was about 48 hrs after irradiation which resulted in the highest percentage of unfertilized eggs at the high temperature (30°C), followed by those at moderate (24°C), and last by the low temperature (18°C) at which a pronounced decrease of unfertilized eggs was observed. Cytological analysis showed that spermatogonia were the most sensitive to radiation and were readily destroyed shortly after exposure. However, the radioinduced sterility in this insect was determined by the fate of spermatocytes at the time of exposure. Almost all the spermatocytes were very sensitive to environmental temperatures post-irradiation. Death or functionless abnormal spermatozoa followed irradiation at high temperature and functional normal eupyrene spermatozoa were found in the case of low temperature treatment. Thus the effectiveness of post-irradiation temperature control on the fertility of the irradiated males was demonstrated. (auth)

6628 SUSCEPTIBILITY OF THE DIFFERENT DEVELOPMENTAL STAGES OF RICE WEEVIL, SITOPHILUS ORYZAE L. TO GAMMA RADIATION. Khan, Md. Zainul Abedin; Matin, A. S. M. Abdul Nucl. Sci. Appl., 4: 11-18(Apr. 1968).

A study was conducted on the effects of γ radiation from a ^{60}Co source on all the developmental stages of rice weevil, Sitophilus oryzae. Complete mortality of eggs was obtained by 2,500 R, of larvae by 8,000 R, of pupae by 10,000 R, and of adults by 12,000 R. Production of progeny was stopped at 9,000 R in all the developmental stages. 12,000 R might be considered as minimum effective dose for the control of S. oryzae. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 6672 and 7381.

6629 (DP-1177-1) SAVANNAH RIVER LABORATORY ISOTOPIC POWER AND HEAT SOURCES. PART I. ^{60}Co. Quarterly Progress Report, July–September 1968. Hilborn, H. S. (comp.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Oct. 1968. Contract AT(07-2)-1. 13p. Dep. CFSTI.

Acceptable oxidation behavior was shown by Inconel 600, Hastelloy C, and Hastelloy X in accelerated tests that simulated operation at 1000°C for 50,000 hr. Haynes 25 oxidized more than expected. Seventeen capsules containing high activity ^{60}Co wafers were fabricated, and heating tests were begun at 900 and 1000°C in the High Level Caves. (auth)

6630 (GEMP-1004) AEC FUELS AND MATERIALS DEVELOPMENT PROGRAM. Seventh Annual Report. (General Electric Co., [Cincinnati, Ohio]. Nuclear Materials and Propulsion Operation). Mar. 31, 1968. Contract AT(40-1)-2847. 378p. Dep. CFSTI.

Eleven sections on reactor materials development are included in the report. A separate abstract was prepared for each section. (F.S.)

For abstracts of individual sections see: 6650–6652, 6662–6667, 6705, and 6725.

6631 ANISOTROPY IN SINGLE-CRYSTAL REFRACTORY COMPOUNDS. VOLUME 2. Proceedings of an International Symposium held June 13–15, 1967, Dayton, Ohio. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968. 502p. (CONF-670637-(Vol.2)).

A total of 21 papers is included in Volume 2. A separate abstract was prepared for each of seven of these papers. One paper was previously abstracted in NSA as 22: 757. Papers for which no abstracts were prepared are concerned with defect structure and mechanical properties. (J.R.D.)

For abstracts of individual papers see: 6678, 6701, 6732, and 6749–6752.

6632 THERMAL CONDUCTIVITY. Proceedings of the Seventh Conference Held at the National Bureau of Standards, Gaithersburg, Maryland, November 13–16, 1967. Flynn, Daniel R.; Peavy, Bradley A. Jr. (eds.). Washington, D. C., National Bureau of Standards, 1968. 822p. GPO $6.25. (NBS-SPEC. PUBL.-302; CONF-671110).

A total of 90 papers was presented at the conference. A separate abstract was prepared for each of twelve of the papers. Papers for which no abstracts were prepared are concerned with apparatuses for measuring thermal conductivity, new experimental data on thermal conductivity and thermal diffusivity, and correlations between experimental results and theoretical predictions. (F.S.)

For abstracts of individual papers see: 6269, 6684–6686, and 6736–6743.

Corrosion and Erosion

6633 (AECL-2717) THE INTERNAL OXIDATION OF ZIRCONIUM–YTTRIUM ALLOYS. Wilkins, B. J. S.; Chater, J.; Reich, A. R. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Aug. 1968. 41p. Dep. CFSTI. CAN $1.50.

Internal oxidation of zirconium alloys is discussed with a view to producing dispersion-strengthened alloys for reactor use. A model for internal oxidation is compared with measurements on internally oxidized zirconium-yttrium alloys. Deviations from the ideal kinetics are accounted for in a modified model. Though stable yttria particles can be produced in a zirconium matrix, they are too large to produce dispersion-strengthening. As yttria has a very high free energy of formation (needed to produce small particles) it is unlikely that dispersion-strengthening of zirconium by internal oxidation will be possible with other alloying elements. (auth) (Canada)

6634 (BARC-333) CORROSION STUDIES ON Al–9 PERCENT Si–1 PERCENT Ni ALLOY IN HIGH TEMPERATURE WATER. Gnanamoorthy, J. B.; Balachandra, J. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 6p. Dep.

The corrosion of an Al–9% Si–1% Ni alloy was studied in high-purity water at 260, 300, and 350°C. Weight-gain values were taken to evaluate the rate of corrosion. During the first few days of the exposure the alloy corroded at a very fast rate and subsequently the rate dropped to a very low value. (M.C.G.)

6635 (BARC-334) STUDIES IN THE CORROSION OF ALUMINIUM BASE ALLOYS IN WATER AT VARIOUS pH VALUES. PART I. CORROSION OF ALUMINIUM BASE NICKEL, SILICON, AND MAGNESIUM ALLOYS. Shibad, P. R.; Elayathu, N. S. D.; Balachandra, J. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 9p. Dep.

The influence of pH on the corrosion of aluminum-base–nickel–silicon alloy with and without magnesium in water of pH 5, 6.5, and 8 at 30, 85, and 100°C was studied by weight loss and electrochemical methods. The Al–9% Si–1% Ni alloy has better corrosion resistance than the Al–9% Si–1% Ni–1% Mg alloy at the pH values and temperatures reported. The corrosion rate is found to be maximum at pH 8 at these temperatures for both the alloys. The results obtained were compared with corrosion behaviour of aluminum 1S in water at various pH values and temperatures. (auth)

6636 (BARC-339) STUDIES ON AQUEOUS CORROSION OF ZIRCONIUM AND ZIRCONIUM ALLOYS: REVIEW OF PRESENT STATUS. Gadiyar, P. S. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 44p. Dep.

The behavior of unalloyed zirconium towards aqueous corrosion is reviewed. The development of corrosion-resistant high-strength zirconium alloys such as zircaloys and zirconium-niobium alloys is considered. The role of hydrogen produced during corrosion, the effects of radiation and the various mechanisms proposed to explain the corrosion behavior are described. Work undertaken on the development of a Zr–0.5% Nb–1% Cr alloy is also included. (70 references). (auth)

6637 (BNWL-SA-1719(Rev.)) CORROSION AND HYDRIDING RESPONSE AND OXIDE PROPERTIES OF SIX IRRADIATED ZIRCONIUM ALLOYS. Johnson, A. B. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1968. Contract AT(45-1)-1830. 46p. Dep. CFSTI. (CONF-681105-1).

From Application-Related Phenomenon of Zirconium and Hafnium Symposium, Philadelphia, Pa.

A series of in-reactor corrosion tests were conducted in the ETR in pH-10 NH_4OH at 270 to 280°C. Six Zr alloys were exposed in as-etched and prefilmed (400°C steam) surface conditions. The six alloys were Zircaloy-2, Zircaloy-4, Zr–3Nb–1Sn, Zr–2.5Nb, Zr–1.2Cu–0.28Fe and Zr–1.2Cr–0.08Fe. Exposures were 25, 37, 77, and 174 days in high-flux, low-flux, out-of-flux and out-of-reactor environments. Results from the 174-day exposure are emphasized, but corrosion and hydriding data from the complete test series are compared. A marked uptake in rate between the 77-day and 174-day exposures is attributed to an increase in O level near the end of the deoxygenating resin life. In the 174-day experiment corrosion rates were accelerated on the six alloys at the high flux position, but only on Zr–Cr–Fe specimens at the low-flux position. Prefilming adversely affected the corrosion of Zr–Cr–Fe, Zr–Cu–Fe, Zircaloy-2 and Zircaloy-4 specimens. The alloys containing Nb were the most resistant to in-flux corrosion and hydriding. Hydrogen absorption rates generally followed corrosion rates. Monoclinic zirconium oxide was the principal phase on high-fluence (1.7×10^{21}, n/cm^2, >1 MeV) specimens of the six alloys. Nonuniform oxidation was observed on Zr–Cr–Fe and Zr–2.5Nb alloys, including pustules, pitting and cracks. Banded Cr segregation was observed in a Zr–Cr–Fe oxide and some Cu segregation was observed in a Zr–Cu–Fe oxide; Nb distribution was relatively uniform in a Zr–2.5Nb specimen. (auth)

6638 (BNWL-SA-1929(Pt.2)(Rev.)) CORROSION AND FAILURE CHARACTERISTICS OF ZIRCONIUM ALLOYS IN HIGH-PRESSURE STEAM IN THE TEMPERATURE RANGE 400 TO 500°C. Johnson, A. B. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1968. Contract AT(45-1)-1830. 25p. (CONF-681105-2). Dep. CFSTI.

From Application-Related Phenomenon of Zirconium and Hafnium Symposium, Philadelphia, Pa.

A nuclear fuel failure phenomenon prompted a study of the corrosion properties of the Zircaloy-2 fuel cladding. The principal studies were conducted at 400, 450, 475 and 500°C in steam at 1700 psig. Materials tested were: five lots of Zircaloy-2; one lot of Ozhennite (Zr–0.2Sn–0.1Fe–0.1Ni–0.1Nb) and one lot of crystal bar zirconium. As-fabricated Zircaloy-2 underwent a rapid approach to failure in tests at 475 and 500°C. The attack involved nucleation of nodular oxide which spread across the surface, finally resulting in an accelerated, relatively uniform

attack. Ozhennite was resistant to the attack. Heat treatments (α and β anneals) suppressed the nodular attack on Zircaloy-2 but not on crystal bar zirconium. (auth)

6639 (LA-4013) SPALLATION CRITERIA FOR NUMERICAL COMPUTATIONS. Thurston, Rodney S.; Mudd, William L. (Los Alamos Scientific Lab., N. Mex.). Sept. 1968. Contract W-7405-eng-36. 12p. Dep. CFSTI.

Spallation is the fracture of a material in dynamic tension. Previously published spallation criteria were dependent on stress rate, stress gradient, and cumulative damage models. A modified stress gradient criterion was favored for its ease of application to both hydrodynamic and characteristic calculations and for the availability of suitable data. The criterion states that the tensile stress at which spallation occurs, σ_s, is a function of the static tensile strength, σ_0, and the tensile stress gradient according to $\sigma_s = \sigma_0 + A\,(\Delta\sigma/\Delta x)^B$, where A and B are constants for a given material and temperature. A method is presented for estimating spallation criteria from static tensile strength data for metals. The method is useful for estimating spallation criteria when experimental data are unavailable and when temperatures are other than those at which the data were collected. The stress gradient spallation criterion is compared with results from experiments which produced zone yielding in copper and spall planes in a copper-aluminum-copper sandwich. (auth)

6640 (NSJ-tr-138) ON THE POLYMORPHIC TRANSFORMATION OF ZIRCONIUM DIOXIDE ASSOCIATED WITH THE BREAKAWAY DURING HIGH TEMPERATURE OXIDATION OF Zr AND SOME Zr ALLOYS. Nakayama, Tadayuki; Koizumi, Tatsuya. Translated from Nippon Kinzoku Gakkaishi, 31: 839-45(July 1967). 16p. Dep.

The breakaway phenomena of Zr and some Zr alloys during high temperature oxidation were studied from a structural point of view, by means of high temperature x-ray diffraction, thermal gravimetry, optical microscopy, and differential thermal analysis. The structural change in oxide scale at breakaway is in close relation with the polymorphic transformation of zirconium dioxide (tetragonal ⇌ monoclinic). The continuous observation of change in oxide scales with high temperature x-ray diffraction clarified that black colored pre-breakaway oxide layers contained a considerable quantity of metastable tetragonal oxide, and that the color of oxide layers from black to white and the polymorphic transformation to monoclinic oxide occurred simultaneously at breakaway. The contents of tetragonal modification in pre-breakaway oxide scales on Zr alloys containing Ti or Sn were larger than that on pure Zr, and this agrees reasonably with the facts that the breakaway occurs at lower temperatures on those alloys, and that those elements lower the transformation temperature of zirconium dioxide. In the stable region of the tetragonal form, the breakaway did not occur in O_2. (auth)

6641 (ORNL-4301) NIOBIUM-1 PERCENT ZIRCONIUM BOILING-POTASSIUM FORCED-CIRCULATION LOOP TEST. Jansen, D. H.; DeVan, J. H.; Cunningham, C. W.; Fuller, L. C.; MacPherson, R. E. (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 123p. Dep. CFSTI.

A Nb-1% Zr boiling-potassium forced-circulation loop, incorporating a test section with three stages of nozzles and simulated turbine blades, was operated for 3000 hr. The nozzles were designed to provide potassium vapor over the quality range of 83 to 97% and temperature range of 1016 to 682°C to impinge on the Nb-1% Zr simulated blade specimens. Potassium vapor at the test section inlet was normally maintained at 1082°C, but periods of unstable boiling with resultant loop temperature fluctuations occurred throughout the loop operation. Surfaces throughout the loop were unchanged as a consequence of potassium exposure except for the second-stage blade specimen. This blade specimen had been subjected to relatively high-velocity (3080-ft/sec) and wet (83%-quality) vapor during the test. The leading edge of this specimen was roughened to a depth of 0.001 in. Oxygen transfer from the potassium bath to the Nb-1% Zr alloy was observed; the greatest increase occurred in the hotter loop regions. (auth)

6642 RESEARCH ON CORROSION OF REACTOR MATERIALS IN FLOWING SODIUM MELT AT HIGH TEMPERATURES. Borgstedt, Hans Ulrich; Drechsler, Guenther; Krees, Guenther (Inst. fuer Material- und Festkoerperforschung, Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Werkst. Korros., 18: 894-7(1967). (In German).

Tests for corrosion were made on materials used in fuel elements for sodium-cooled reactors. The tests were performed in sodium flowing at a rate of 0.5 m/sec at 500 to 600°C. The tests were conducted in a loop constructed of high grade steel. Sodium was circulated electromagnetically. The degree of Na corrosion of high grade austenitic steels and nickel based alloys is low. Corrosion of vanadium-based alloys is greatly influenced by the oxide content in the Na. (TSS)

6643 CORROSION RESEARCH ON NIOBIUM-TANTALUM ALLOYS. Kieffer, R.; Bach, H.; Stempkowski, J. Werkst Korros., 18: 782-4(1967). (In German).

Electrical and mechanical properties of Nb, Ta, and their alloys are discussed. Corrosion behavior in mineral acids and in potash lye is reported. The expensive Ta content in Nb-Ta alloys can be significantly reduced without the alloy losing its high corrosion resistance to aqueous solutions. (TSS)

6644 NEW ALLOYS OF ZIRCONIUM RESISTANT TO OXIDATION: THE ZIRCONIUM-COPPER ALLOY. Darras, R.; Loriers, H.; Baque, P.; Berry, J. L. (CEN, Saclay, France). J. Nucl. Mater., 28: 257-70(1968). (In French).

Corrosion studies at the CEA have suggested the use of binary zirconium-copper alloys as canning materials for fuel elements in advanced reactors cooled by carbon dioxide. The addition of copper at concentrations between 1.6 and 3.0 wt % slows down, or even suppresses, the increase of oxidation rate which normally affects zirconium and most of its alloys above a certain temperature and which prevents their use in the presence of carbon dioxide above 550°C. Alloying with copper causes a relatively uniform layer of zirconium oxide to form at the alloy surface and also limits the development of cracks. Such alloying has little effect on the embrittling diffusion of oxygen inside the alloy. A concentration of 2.5 wt % of copper seems to be the best from the point of view of corrosion and its superiority is confirmed above 600°C. Nevertheless an alloy containing 1.6 wt % has merits because of its lower neutron capture cross-section. The investigation established the influence of various factors, such as the presence of impurities in gas phase, thermal cycling, applied stresses, neutron irradiation and the role of ternary addition elements. In particular, the presence of water vapor in the carbon dioxide markedly accelerates corrosion, but hydrogen adsorption does not appear to be prohibitive, especially since it diminishes as the copper content of the alloy is increased. A maximum temperature of 600°C appears to constitute at present a reasonable limit for the use of cans made of Zr-Cu alloys, taking into account the conditions of reactor use. (auth)

6645 CORROSION-RESISTANCE OF PURE NIOBIUM IN AGGRESSIVE MEDIA. Gratsianskii, N. N.; Bogacheva, N. A.; Zhabitskaya, S. A. (Odessa Inst. of General and Inorganic Chemistry). Ukr. Khim. Zh., 34: 1073-5(1968). (In Russian).

Corrosion resistance of pure Nb in 20% HCl, 70% H_2SO_4, and 30% H_2SO_4 was studied. The most aggressive effects on Nb were observed with 30% NaOH. Graphical data are given on the effects of time, temperature, and solution on the rate and resistance of Nb to corrosion. (R.V.J.)

6646 FIELD ION MICROSCOPY STUDY OF THE FORMATION OF OXIDE PARTICLES ON TUNGSTEN. Brenner, S. S.; McVeagh, W. J. (United States Steel Corp., Monroeville, Pa.). J. Electrochem. Soc., 115: 1247-52(Dec. 1968).

The induction period for the formation of oxide particles on tungsten was found to be inversely proportional to $(p_{O_2})^{0.8}$ and exponentially related to 1/T indicating an activation energy of 21 ± 2 kcal/mole. The particles appear to be irregularly shaped, and their distribution is crystallographically nearly homogeneous. It is proposed that the length of the induction period is determined primarily by the rate of penetration of oxygen into the tungsten lattice. (auth)

6647 X-RAY INVESTIGATION OF THE SCALE FORMED UPON OXIDATION OF ALLOYS IN THE Nb-Zr SYSTEM. Tsirlin, M. S.; Kovba, L. M. Vestn. Mosk. Univ., Ser. II. Khim., No. 5, 4-7(Sept.-Oct. 1968). (In Russian).

The phase composition of the scale formed upon oxidation of alloys in the Nb-Zr system was investigated in the temperature range 550 to 950°C. The high-temperature modification of Nb_2O_5 was not found in the scale. (auth)

6648 STRUCTURAL CHANGES IN MATERIALS EXPOSED TO LIQUID SODIUM. Thorley, A. W.; Bardsley, J. A. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). J. Roy. Microscop. Soc., 88: 431-47(Nov. 1968).

Experiments were carried out to demonstrate the mass transfer of elements in liquid sodium. The transferring species, which can affect the microstructure and surface topography of certain materials, can be broadly classified as two types, (a) those that exist in sodium as impurities, such as oxygen or carbon, and (b) those that are transferred via the liquid metal from the containment material. With the aid of optical and electron photomicrographs and supporting x-ray, chemical, and microprobe analysis four

typical reactions are illustrated. These are: oxidation of certain refractory metals and stainless steels in liquid sodium; solution of elements to cause surface transformations in stainless steel; selective leaching of metalloids such as phosphorus and silicon from nickel-base alloys; and mass transfer of carbon to produce decarburization and carburization of certain ferritic and stainless steels, respectively. (auth)(UK)

6649 CORROSION AND OXIDATION RESISTANCE OF IGETALLOY. Hara, A.; Saito, Y. Sumitomo Denki, No. 98, 65-82(Oct. 1968). (In Japanese).

Cemented carbides, trade name Igetalloy, have such excellent mechanical, physical, and chemical properties that they are ideal materials for many industrial applications. Recently they were applied to more extensive fields, not only as cutting tools, but also as various parts, such as compressor liners, very-high pressure vessels, seal rings, rolls for special uses, and many others. For these new applications of cemented carbides, it was necessary to examine their corrosion and oxidation resistance. Results obtained on these properties of Igetalloy are reported. (auth)

Preparation and Fabrication

Refer also to abstracts 6643, 6668, and 6720.

6650 (GEMP-1004, pp 178-97) ADVANCED FAST BREEDER REACTOR FUEL ELEMENT CLADDING DEVELOPMENT. Funston, E. S.; Tarr, C. O. (General Electric Co., [Cincinnati, Ohio]. Nuclear Materials and Propulsion Operation).

Equipment was installed for producing refractory metal bars, seamless tubing sheets, and wires. An electronically controlled draw bench to control the drawing speeds of seamless refractory metal tubing is described. Fine Os-W wire (dia 0.0076 cm) was drawn for thermocouple application. Molybdenum purification has resulted in unalloyed Mo sheet production. The Mo sheets are ductile, free of microporosity in weld-heat-affected areas, and have stress-rupture life and deformation resistance equal to Mo-Re alloys at 1600°C and superior to those alloys at 2200°. (F.S.)

6651 (GEMP-1004, pp 198-215) PHYSICAL METALLURGY OF FAST BREEDER REACTOR CLADDING MATERIALS AND REFRACTORY METALS. Collins, C. G.; Bohlander, K. M. (General Electric Co., [Cincinnati, Ohio]. Nuclear Materials and Propulsion Operation).

Studies on Re-Mo-W alloys led to lower cost production procedures and greatly improved room temperature ductility properties of powder metallurgy materials used for fast breeder reactor fuel cladding materials. Data are presented for ductility, grain size, hardness, recrystallization, and changes in aging at temperatures up to 2000°C for periods up to 1000 hrs. (F.S.)

6652 (GEMP-1004, pp 316-50) PHYSICO-CHEMICAL STUDIES OF CLAD UO_2 IN POTENTIAL MELTDOWN ENVIRONMENTS. White, J. F. (General Electric Co., [Cincinnati, Ohio]. Nuclear Materials and Propulsion Operation).

Behavior of zirconium alloy clad UO_2 fuel elements in steam and air at 1000°C to the melting point of UO_2 was studied. Heating tests of Zircaloy-4 tubes with internal pressure show that steam oxidation of the metal results in lower deformation rates, less deformation, and higher failure temperature. Air oxidation of Zircaloy-4 is erratic and occurs at a greater rate than in steam due to the reaction with N in the air. Rate-controlling mechanism for UO_2 oxidation by steam is the diffusion of O through UO_{2+x} lattice. The air oxidation rate of 304 stainless steel is about 10^3 times less than the rate in steam up to 1370°C due to excess Cr_2O_3 film formation. During steam oxidation, the film provides less protection because of its spinel structure. Tensile strength of annealed 304 L decreased from 0.66 kg/mm^2 at room temperature to 0.86 kg/mm^2 at 1375°C. Thermal conductivity increased with temperature. The spectral emittance of Zircaloy-4 varied. Solution of O in the metal during prolonged heating caused spectral and total emittance to approach the values of the unoxidized metal. (F.S.)

6653 (SC-R-68-1865) ION PLATING. Mattox, D. M. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1968. 16p. Dep. CFSTI.

A generalized description of the "Ion Plating" process is given, along with its various modifications. The uses and limitations of the process are outlined. The process has been shown to be a useful tool to the laboratory and production technologist. The technique utilizes equipment which is normally associated with the vacuum and sputtering technologies and is, therefore, an easy tool to acquire. A bibliography of pertinent publications is included. (auth)

6654 STUDY OF THE ADHESION OF NICKEL. Bradford, James McLure Jr. Raleigh, N. C., North Carolina State of the Univ. of North Carolina, 1968. 108p.

Thesis.

An investigation was conducted to determine the parameters which control the adhesion (cold-welding) of nickel to nickel at a pressure of about 10^{-9} torr. The surfaces were prepared by argon ion bombardment and heating. The change in the work function of the test samples during the cleaning procedure was used to indicate the degree of cleanliness of the surfaces and was correlated to the change in the adhesion coefficient during the cleaning procedure. The adhesion coefficient was at its maximum value when the surface was in its cleanest state. The adhesion coefficient was measured by first cleaning the surface, putting the samples together with a contact force normal to the surfaces, and then measuring the force required to break the adhesion joint formed. Results showed that both the ion bombardment and heating parts of the heating cycle were necessary to achieve adhesion at ambient temperatures. Exposure of the clean surfaces to the residual gases in the vacuum system for long periods of time (1 hour) did not reduce the adhesion coefficient but exposure to 10^{-4} torr-seconds of oxygen reduced the adhesion coefficient to zero. The adhesion coefficient decreased with increasing hardness. The adhesion coefficient was constant at about 0.2 for very small contact pressures up to the contact pressure necessary to cause plastic deformation in the bulk of the nickel. At that pressure the adhesion coefficient increased with increasing contact force. The adhesion coefficient increased with increasing temperature during the time in contact. (Diss. Abstr.)

6655 METALLOGRAPHIC PREPARATION OF BERYLLIUM BY ELECTROLYTIC LAPPING. Price, C. W. (Battelle Memorial Inst., Columbus, Ohio). Contract AT(29-1)-1106). Metallography, 1: 5-18(Sept. 1968).

An electrolytic lapping technique has been developed for beryllium. Good metallographic polishes are obtained, and the high rates of material removal that are characteristic of this technique provide an efficient means of removing the worked layer that is formed during mechanical grinding and polishing. This technique gives good inclusion retention with only negligible pitting around the inclusions that are attacked by the electrolyte. Another advantage of this technique is that iron-containing precipitates are sharply delineated. Excellent preservation of edges of microcracks and voids are also obtained by the use of alternate mechanical polishing and electrolytic lapping. The technique can be used on either wrought or powder-pressed specimens. (auth)

6656 INVESTIGATION ON THE DEOXIDATION OF SINTERED MOLYBDENUM WITH CARBON, BORON, AND SILICON. Lutz, H.; Benesovsky, F.; Kieffer, R. (Technische Hochschule, Vienna). J. Less-Common Metals, 16: 249-64(1968). (In German).

The deoxidation additives C, B and Si, which are normally used in arc-melted Mo, were tested on Mo under different sintering conditions. The additives were mixed with the Mo powder in the form of finely divided intermetallic compounds. In addition to accurate chemical analyses, metallographic and mechanical properties were determined as a criterion of the deoxidation efficiency of these additions. Mo sintered with additions of C, B, or Si contained less than 15 ppM O, independent of the nature and quantity of addition and sintering method. Boron additions of 100 ppM (approx. 10 ppM in the sintered bars) produce very considerable grain refinement; C is only half as effective and Si still less effective. Additions of 0.05 to 0.15% of B (0.02 to 0.05% in the sintered bar) and 0.02 to 0.10% of C (0.01 to 0.05% in the sintered bar) markedly improve the bend ductility of sintered Mo; as little as 0.01% silicon causes embrittlement. Molybdenum with 0.035 to 0.040% Si has minimum hardness. In contrast to the literature, C was found to have only a slight hardening effect; B, however, is very effective in this respect. The most favorable tensile and elongation values in sintered Mo deformed at 200°C were achieved by B additions of 0.01 and 0.05% and C additions of 0.02 and 0.05%, respectively. Sintered recrystallized Mo with small additions of B is extremely ductile and has remarkably large elongations down to -60°C with good tensile strength. Recrystallized technical Mo of normal purity is brittle in this temperature range. The extremely favorable effects of small B additions on the properties of sintered Mo are probably associated with the temperature-dependent solution and precipitation of molybdenum boride phases. It is anticipated that these alloys can be precipitation hardened. (auth)

6657 CHEMICAL-MECHANICAL POLISH FOR TUNGSTEN. Newton, C.; Olson, D. L. (Cornell Univ., Ithaca, N. Y.). Metallography, 1: 249-50(Nov. 1968).

A chemical-mechanical polish for preparing single or polycrystal tungsten consists of hand grinding on SiC paper, and chemical

polishing using ammonium hydroxide–hydrogen peroxide solution poured on an abrasive polishing wheel with a polyethylene lap which has a kitten ear broadcloth cover. The specimen is thus chemically and mechanically polished. This technique can be used with germanium, niobium, tantalum, and vanadium. (F.S.)

6658 MICROSTRAIN CHARACTERISTICS OF ISOSTATICALLY HOT-PRESSED BERYLLIUM. Shemenski, R. M.; Maringer, R. E. (Battelle Memorial Inst., Columbus, Ohio). J. Less-Common Metals, 17: 25-45(Jan. 1969).

Polycrystalline beryllium specimens were fabricated from powders by using significantly higher pressures and lower temperatures than are normally employed for commercially compacted beryllium. The procedures involved encasement of a partially compacted powder in a collapsible steel container; the container was externally isostatically pressurized by hot gas (helium), or a solid pressure-transmitting medium (steel or Al_2O_3, etc.) enclosed in a cavity and acted upon by the ram of a forging press. A finer initial powder-particle size and distribution were found to result in a smaller as-fabricated grain size. Microyield strength of as-fabricated, low-oxide beryllium decreased with decreasing grain size. However, on heat treating at 924°C for 30 min after pressing, microyield strength increased with decreasing grain size. Microyield strength also increased with decreased processing temperature, increased beryllium oxide content, and small alloying additions of chromium or silver. Flow stress of isostatically pressed beryllium was found to be a parabolic function of microstrain. The flow curves were characterized by three distinct ranges of microstrain: heterogeneous basal glide at low microstrains; dispersion hardening, most probably by a dislocation pile-up mechanism at intermediate levels of microstrain; and prismatic glide and cross-slip at microstrains greater than 50×10^{-6}. Microflow behavior of isoforged beryllium was a sensitive function of the time held at pressure during final consolidation, probably due to the effect of pressure on the solubility of precipitates. (auth)

6659 CAUSE OF CRACKING IN THORIUM DURING FUSION WELDING. Marcellin, W. J.; Landon, P. R. (Univ. of California, Livermore). Weld. J. (N. Y.), 47: 575-s-6(Dec. 1968).

The cracking during fusion welding of thorium was found to be related to the loss of ductility above 860°C. The hot-short condition was found to be due to a low-melting grain boundary constituent, mainly a Th–Fe eutectic. It was shown that weld-cracking in thorium can be virtually eliminated if the purity of the thorium can be adequately controlled. Based on test results, greater than 600 ppM of iron in thorium causes severe hot-short cracking. Since molybdenum improves the weldability of thorium, it was concluded that molybdenum combines with iron to form a high-melting compound. Since high iron and nickel contents are characteristic of calcium-reduced thorium, electrorefined material should be used for "sweetening" manufacturing plant feed. (D.H.M.)

Properties Evaluations

Refer also to abstracts 6650–6652, 6705, 6730, and 6742.

6660 (BNWL-SA-1821) FATIGUE CRACK GROWTH AND PROPAGATION IN Zr–2.5 WT. PERCENT Nb ALLOY PRESSURE TUBING. Pankaskie, P. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 10, 1968. Contract AT(45-1)-1830. 22p. (CONF-681105-3). Dep. CFSTI.

From Application-Related Phenomenon of Zirconium and Hafnium Symposium, Philadelphia, Pa.

Zr–2.5 wt% Nb alloy tubes were fatigued in the tension-tension mode by cyclic internal pressures to cause axial crack growth and unstable fractures at room temperature. Pressure cycle rates were 400 and 3000 cycles per hour. Both the cold worked and heat treated conditions, before and after hydriding (200 to 300 ppM H_2) were investigated. Tests were used to determine the effect of the axial length of the surface stress intensifying defect, and multiple surface stress intensifying defects on fatigue crack initiation growth and critical length at unstable fracture. Fatigue crack initiation and growth were found to occur at nominal peak hoop stresses equal to or less than the estimated endurance limit (~25,000 psi). For fatigue cracks initiated at the outside diameter surface, the shape of the crack front is semicircular. The number of stress cycles required to initiate fatigue cracking at the surface is inversely proportional to the square of the surface defect length. Crack growth rates, for non-hydrided tubing are proportional to ΔK to the fifth power, and to ΔK to the fourth power after hydriding. Critical crack length at unstable fracture decreased with an increase in the number of fatigue cycles required to initiate fatigue cracking. Multiple defects may act to initiate unstable fracture. Fracture toughness of the heat treated tubing before hydriding is less than for the cold worked condition either before or after hydriding, and after hydriding the fracture toughness is further reduced. (auth)

6661 (EURFNR-534) CREEP RUPTURE STRENGTH AND CREEP BEHAVIOR OF VANADIUM–TITANIUM AND VANADIUM–TITANIUM–NIOBIUM ALLOYS. Boehm, H.; Schirra, M. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Translated from report KFK-774. 65p. (EUR-3954). Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Studies were performed on the creep rupture and creep behavior of binary V–Ti and ternary V–Ti–Nb alloys in the temperature range above 650°C. The results show the prominent influence of the titanium on the creep rupture and creep behavior of the alloys. For titanium contents of above about 1% the creep rupture strength drops for rising titanium concentrations, while the short-time high-temperature strength rises, regardless of the niobium content. For increasing niobium contents the holding time is increased, but the influence of the niobium drops for rising holding times, so that the $\sigma_{B/10,000}$ values depend to a small degree on the niobium content. The best vanadium alloys show long-time strength values which can barely be reached by any other materials. A marked dependence on the titanium content is also displayed by the creep activation energy in the temperature range around 650°C, while the niobium content has no influence upon this quantity. The studies indicate that the creep rupture and creep behavior of the alloys are also determined by the interactions between titanium and the interstitial impurities at high titanium contents. (tr-auth)

6662 (GEMP-1004, pp 14-88) PHYSICAL AND MECHANICAL PROPERTIES OF REACTOR MATERIALS. Conway, J. B.; Flagella, P. N. (General Electric Co., [Cincinnati, Ohio]. Nuclear Materials and Propulsion Operation).

High temperature (to 3000°) physical and mechanical properties for commercially available and newly developed materials being considered for use in high temperature reactors were measured. Creep, stress rupture, ductility, microstructure, and failure mechanism for tungsten were determined. Values were found for creep of as cast Mo; creep rupture of Re, Mo–Re–W, Mo–W, and Re–W; thermal conductivity and electrical resistivity of Re–W; and enthalpies, heat content and heat capacity of W. (F.S.)

6663 (GEMP-1004, pp 216-41) FAST BREEDER REACTOR FUEL ELEMENT CLADDING RESEARCH. Robertshaw, F. C.; Bartos, J. L. (General Electric Co., [Cincinnati, Ohio]. Nuclear Materials and Propulsion Operation).

Comparative tensile yield, stress rupture, creep strength, and other data are given for Cr-base, Al–Cr–Fe–Y, iron base (ferritic) and iron base (austenitic) alloys in studies for developing improved fast breeder reactor fuel element cladding materials. Data used in tensile and yield strengths except for austenitic stainless steel are based on tests of specimens from 3.6 to 5.5 kg vacuum-induction melted laboratory heats extruded and rolled to ~0.076 cm sheet. Tests on all alloys other than air tested Al–Cr–Fe–Y system were in argon atmosphere. The stainless steel was in the form of 0.076 cm sheet and was annealed at 1120°C for ½ hr. then water quenched. Beyond 650°C iron base (austenitic) and Cr-base alloys are superior to austenitic stainless steel. The iron base (austenitic) alloy has improved strength, and radiation and structural stability. Chromium base alloys are ductile, corrosion resistant to Na, and exhibit thermal stability. (F.S.)

6664 (GEMP-1004, pp 242-74) EVALUATIONS OF PLASTIC FATIGUE PROPERTIES OF HEAT-RESISTANT ALLOYS. Conway, J. B. (General Electric Co., [Cincinnati, Ohio]. Nuclear Materials and Propulsion Operation).

Parameters affecting low-cycle fatigue life of AISI 304, 316, and 348 were investigated. Test parameters were temperature, strain amplitude, strain rate, and length of hold times at peak strain in each cycle. Metallographic and fractographic analysis of 348 and 304 stainless tested at 650 and 816°C and strain rates of 4×10^{-3}, 4×10^{-4} and 4×10^{-5} sec^{-1} showed that the mode of crack initiation was intergranular for all conditions except for the highest strain rate at 650°C. At these conditions the 304 exhibited a transgranular type crack initiated at the highest and lowest strain range evaluated. The 348 exhibited better strain fatigue resistance for a given total axial or plastic strain level. Fatigue resistance at 316 to 650°C is less than 304 or 348. The 316 exhibited strain hardening followed by softening over the entire range. (F.S.)

6665 (GEMP-1004, pp 275-315) ADVANCED PRESSURE VESSEL MATERIALS. Robertshaw, F. C.; Stephan, H. R.;

McConnelee, J. E. (General Electric Co., [Cincinnati, Ohio]. Nuclear Materials and Propulsion Operation).

Data on 5Cr–3Mo–12Ni alloy, PH13–8Mo and Inconel 718 for pressure vessel application are given. The 5Cr–3Mo–12Ni possesses characteristics suited to uniform aging of heavy sections. Tensile and toughness properties are good, and structural stability up to 315°C is adequate. Weldability with 12Ni–5Cr–3Mo filler material is good but 12Ni–5Cr–3Mo filler is more efficient. Aging characteristics of PH13–8Mo may not be suited to uniform aging of heavy sections. Excellent tensile properties and good toughness can be developed. The alloy is structurally stable at long time heating at 425°C. Good weldability with filler metal of matching composition was exhibited but weld ductility and toughness are only fair. (F.S.)

6666 (GEMP–1004, pp 351–60) FAST BREEDER REACTOR THERMOCOUPLE DEVELOPMENT. Funston, E. S.; Kuhlman, W. C. (General Electric Co., [Cincinnati, Ohio]. Nuclear Materials and Propulsion Operation).

Studies of very high-temperature thermocouple characteristics for instrumentation and electrical components used in fast breeder reactors showed that the thermoelectric emf produced along BeO, HfO_2, or ThO_2 insulators can affect the output of the thermoelements. Bare-wire thermocouples are influenced by environment. Radiation effects on W versus W–Re thermocouples in the ORR after ~2 months in a 1.2×10^{14} n/cm²-sec thermal and 2.1×10^{13} n/cm²-sec fast flux indicate that W and W–Re thermoelements shift similarly in thermal emf, resulting in a positive error of 5°C. Hafnates such as $CaHfO_3$, $SrHfO_3$, and $SrZrO_3$ were found to be inferior to BeO and HfO_2 as thermocouple insulating materials. (F.S.)

6667 (GEMP–1004, pp 361–8) PHYSICO-CHEMICAL STUDIES OF Fe–Cr–Al-CLAD FUEL SYSTEMS. Edwards, H. S.; Bohlander, K. M. (General Electric Co., [Cincinnati, Ohio]. Nuclear Materials and Propulsion Operation).

Reactions which can occur between oxidation-resistant Fe–Cr–Al-base alloys and UO_2 at 500 to 1200°C are discussed. Aluminum in the Fe–Cr–Al-base cladding reduces the UO_2 in the cermet fuels at 1000 to 1200°C. The U dissolves and diffuses through the cladding and is converted to an oxide. Oxygen combines with Al forming Al_2O_3 which inhibits Al diffusion into the UO_2. The diffusion for Al in Cr leads to the development of a Cr barrier and reduces the Al–UO_2 interaction and eliminates surface contamination. Free U as substoichiometric UO_{2-x} diffuses through 0.38 mm cladding within 100 hrs at 1000°C or in 6 hrs at 1200°C. At 1000°C, U solubility in Fe–Cr–Al-base alloy is 0.1 to 0.2% and its diffusion coefficient is in the range of 10^{-9} to 10^{-10} cm²/cm. (F.S.)

6668 (RPI–3820–2) STUDY OF THE EFFECT OF HYDROSTATIC PRESSURE ON SELF-DIFFUSION RATES IN HEXAGONAL METALS. Progress Report. Glider, H. Michael (Rensselaer Polytechnic Inst., Troy, N. Y.). Oct. 1968. Contract AT(30-1)-3820. 7p. Dep. CFSTI.

Crystallographically oriented a- and c-axes single crystals of zinc and cadmium were prepared and diffusion coefficients for ^{110}Ag and ^{65}Zn in zinc were measured at atmospheric pressures in an investigation of the principal-axis activation volumes of cadmium and zinc. Single crystals were plated with ^{110}Ag and ^{65}Zn and the effect of pressure on the simultaneous diffusion of ^{110}Ag and ^{65}Zn in zinc in a direction 25° from the a-axis was measured at 368.7°C. (F.S.)

6669 (UCRL–18526) EXPERIMENTAL CORRELATIONS FOR HIGH-TEMPERATURE CREEP. Mukherjee, Amiya K.; Bird, James E.; Dorn, John E. (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 1968. Contract W-7405-eng-48. 84p. (CONF-681018–2). Dep. CFSTI.

From Symposium on Dislocation Climb and High Temperature Processes, ASM, Detroit, Mich.

The present status of experimental knowledge of the high-temperature creep of some metals and alloys is evaluated with particular reference to the significance of climb of dislocations. The effects of the independent variables of stress and temperature on the creep rate and the possible influence of crystal structure, modulus of elasticity, stacking-fault energy, and grain size on these data are discussed. The major substructural changes that accompany high-temperature creep are reviewed. A summary is presented on the theoretical implications of the known experimental facts relative to the validity of various proposed high-temperature creep mechanisms. (L.C.L.)

6670 AN X-RAY DIFFRACTION STUDY OF THE AGING REACTION IN TWO AUSTENITIC ALLOYS. Abraham, J. K.; Wilson, T. L. (Republic Steel Corp., Cleveland). Advan. X-Ray Anal., 11: 434–46(1968).

From 16th Annual Conference on Applications of X-Ray Analysis, Denver, Colo. See CONF-670813.

Aging processes exhibiting cluster to precipitate transitions were studied in polycrystalline austenitic iron-base alloys with a Siemens' Guinier camera. This camera combines the Seemann–Bohlin focusing geometry with a curved-crystal monochromator and thus maximizes the resolution of observed sidebands and the weak precipitate lines. Growth studies encompassing a cluster-size range of 15 to 70 unit cells were followed. For the systems of interest, this coincided with a variation from detectable hardness increase to a stage of maximum hardness immediately preceding precipitation. Cluster sizes were calculated on the basis of the Guinier model; variation with time and temperature permitted calculations of an apparent activation energy in the one system where decomposition was spontaneous. An iron–nickel–titanium alloy was used to study aging in a ternary system. Behavior was classic in that the cluster size present on quenching grew with aging coincident with a simultaneous hardness increase. Calculation of activation energies indicated strongly that transportation of nickel to, or iron from, the cluster was rate determining. Upon overaging, the nickel–titanium enriched clusters gave way to the hexagonal Ni_3Ti phase. An iron–nickel–chromium–niobium quaternary, in addition to presenting a clustering system similar to the above ternary, showed two rather interesting phenomena. First, chromium was necessary for precipitation; the ternary iron–nickel–niobium did not age. Secondly, a stable Fe_2Nb Laves phase present upon quenching from 2200°F disappeared on aging in favor of nickel–niobium clusters; an incubation time for the formation of these clusters existed, and its duration was about 4 hr. An asymmetry was noted in the diffraction intensities about the (311)γ line in both systems. In the iron–nickel–titanium case, the asymmetry was only in intensity, whereas, with the iron–nickel–chromium–niobium alloys, the asymmetry existed in both intensity and position. Interpretation of these observations is made on the basis of anticipated variations in scattering factors, lattice spacings, and cluster sizes. (auth)

6671 DISCONTINUOUS STRESS RELAXATION IN TANTALUM. Pink, E. (Metallwerk Plansee AG, Reutte/Tirol, Austria). J. Less-Common Metals, 16: 279–84(1968). (In German).

Samples of commercially pure recrystallized sintered Ta were stretched on a tensile-testing machine with a deformation rate of about 2×10^{-3}/sec to about 10%. The stress relaxation was measured as a function of time. At room temperature after 30 min there was no additional relaxation. Up to 300°C a normal pattern of the stress relaxation was observed. The time dependence of σ is a simple function $\sigma = \sigma(t)$. Studies at 400°C show after an initial decrease an additional increase of the relaxation curve up to a maximum and then another decrease. Up to research temperatures of 600° there is no regularity to the always stronger occurring deformations. At 800°C several maxima are detectable during the 30-minute relaxation. The mechanisms responsible for the relaxation behavior are discussed. (J.S.R.)

6672 EFFECTS OF THE OXIDIZING REACTIONS WHEN HIGH-TEMPERATURE ALLOYS ARE WELDED ON THE STRUCTURE AND PROPERTIES OF THE DEPOSITED METAL. Erokhin, A. A.; Kotov, G. N. (Inst. of Metallurgy, Moscow). Avtomat. Svarka, No. 10, 16–20(Oct. 1967).

The effects of the oxidizing potential of $CaCO_3$ and Ni_2O_3 coatings on the high-temperature strength, mechanical properties, and susceptibility to hot cracking of Cr–Mo–Ni surface metal was investigated. Increasing the oxidation potential of the coating and the ratio of CaO to SiO_2 decreased the Si content and heterogeneity of the structure. This led to lower hot cracking resistance at high Mo concentration. The strength of the metal increases with high-temperature. The plasticity of the surface metal after welding depends slightly on the oxidation potential of the coating and is determined primarily by the Mo concentration. (F.S.)

6673 METALLOGRAPHIC EXAMINATION OF ELECTRON-BEAM-MOLTEN NIOBIUM ALLOYS. Malli, M. (Fried-Krupp, Essen). Radex Rundsch., No. 3/4, 805–10(Aug. 1967). (In German).

Melts of carbon-free and carbon-containing Nb alloys produced by vacuum electric arc's and electron beams were compared in regard to structural composition, degree of purity and homogeneity. Electron-beam melts are purer and the alloys which contain carbon have smaller grain size than the carbon free alloys. The use of master alloy rather than powder materials improved homogeneity. Results on preliminary recrystallization behavior of extruded alloys and on structural changes during creep experiments at 1100°C are reported. (TSS)

6674 SOME METALLOGRAPHIC TECHNIQUES APPLIED TO MOLYBDENUM SINGLE CRYSTALS. III. TWO STAGE FOIL THINNING TECHNIQUE. Irwin, Gerald J.; Otto, Brigitte (Imperial Coll. of Science and Tech., London). Prakt. Metallog., 5: 382-7(July 1968). (In German and English).

Well-known thinning techniques have been adapted in two stages to molybdenum single crystal for the purpose of study by electron microscopy. The combined technique is useful for its reproducibility over a large range of crystallographic planes. (auth)

6675 A STUDY OF MORPHOLOGY AND DISPERSION OF PRECIPITATES IN LOW-ALLOY URANIUM-ALUMINIUM AND URANIUM-SILICON ALLOYS. Truchly, Jan; Novak, Jiri (Ustav Jaderneho Vyzkumu, Rez, Czech.). Kovove Mater., 5: 135-49(1967). (In Czech).

A method was developed for observation of precipitates in dilute uranium alloys by means of electron microscopy applying the replica method. The precipitate-dispersion was evaluated quantitatively. In U-Al (~0.1%) alloy, a dispersion of globular precipitates of the UAl_2-phase comparable with the precipitate-dispersion in the adjusted uranium U-Al (0.05 to 0.12%)-Fe (0.02 to 0.05%), was found. The mean distance d of particles in the plane section depends on heat treatment of the alloy. The mean distance in the alloy quenched from the β-region and annealed at 550°C/5 hours was found d ~0.24 μ. During annealing in the α-region, the coagulation of precipitate takes place. In U-Si (0.05 to 0.075%) and U-Si (0.1 to 0.15%) alloys, the U_3Si-phase precipitates in the range of temperatures 530-600°C forming lamellae arranged parallel in colonies with an interlamellar distance of 0.1 to 0.2 μ. At higher temperatures, a formation of lamellae-colonies with larger mean interlamellar distance occurs. During annealing in the α-region, the original colonies of lamellae change into a group of incidentally distributed and parallel oriented platelets and coagulation of the precipitate takes place. For the U-Al alloy, there was found a linear relation between the hardness H_{V30} measured at normal temperature and the reciprocal value of the mean distance between the precipitate-particles. In U-Si alloys containing lamellae colonies of the U_3Si-phase, the hardness does not depend, at constant volume-fraction of the precipitate, on the interlamellar distance and enhances with increasing precipitate volume-fraction. As compared with the U-Al alloy containing a globular precipitate of the UAl_2-phase, another mechanism of strengthening is here effective. (auth)

6676 ANISOTROPY IN EMISSIVITY OF SINGLE-CRYSTAL REFRACTORY MATERIALS. Autio, G. W.; Scala, E. (Cornell Univ., Ithaca, N. Y.). pp 357-81 of Anisotropy in Single-Crystal Refractory Compounds. Vol. 1. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio. See CONF-670637-(Vol.1).

The effect of anisotropy on normal spectral emissivity has been investigated both experimentally and theoretically. Measurements include data on the two major crystallographic faces of single-crystal beryllium and zirconium, pyrolytic boron nitride, and pyrolytic graphite. The results were obtained at temperatures near 800°C over a wavelength range from visible to near infrared (0.60-11μ) in both purified argon and hydrogen atmosphere. Photomicrographs (up to 1000×), interference photographs, and x-ray orientation patterns were taken of all surfaces before and after the experiments. The probing technique was employed to measure normal spectral emissivity which avoided complicated optics and separation of blackbody cavity and specimens from the same heating conditions. Thermocouple temperature measurements of specimen surfaces and blackbody cavity were made directly. A convenient correction for temperature difference between blackbody cavity and specimens was achieved by means of a macroscopic thermal relation involving the Planck Radiance. Polarized light emissivities were measured for the A-face ("c" axes parallel to surface of the $(10\bar{1}0)$ faces) of the various anisotropic materials investigated. Attempts to compare theory with experiment have been made based on optical constants measurements. Relating the normal spectral emissivity to other physical properties was achieved by coupling the electrical properties, conductivity and dielectric constant, with the optical properties, index of refraction, and extinction coefficient. (auth)

6677 SELECTED PROBLEMS IN THE ANALYSIS OF REFRACTORY MATERIALS. Lynch, C. T.; Vahldiek, F. W.; Mersol, S. A. (Air Force Materials Lab., Wright-Patterson Air Force Base, Ohio). pp 317-39 of Anisotropy in Single-Crystal Refractory Compounds. Vol. 1. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio. See CONF-670637-(Vol.1).

The development of refractory materials for structural and protective applications at very high temperatures is discussed. Research on refractory compounds such as the transition metal carbides, borides, and nitrides has brought into focus attendant problems with analytical methods and chemical standards. As research efforts have become more sophisticated and the available materials have improved in quality, the role of impurities in determining properties has been found of increasing importance. The limitations on methods through lack of standards, problems of non-stoichiometry, localization or segregation of impurities, and inherent deficiencies of methods are discussed. The potential of some of the newer methods of analysis is considered. (auth)

6678 ANISOTROPY IN THE MECHANICAL PROPERTIES OF BERYLLIUM SINGLE CRYSTALS. Conrad, H.; London, G.; Damiano, V. (Franklin Inst. Research Labs., Philadelphia). pp 153-216 of Anisotropy in Single-Crystal Refractory Compounds. Vol. 2. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio. See CONF-670637-(Vol.2).

The dislocation mechanisms associated with the mechanical behavior are identified. Basal, prism, and pyramidal types of slip which operate in beryllium are discussed along with the factors affecting these cases. Twinning occurs in Be in the $\{10\bar{1}2\}$ plane normally, but recent reports of additional twinning are listed. Fracture in the three types of slip is discussed. (J.C.W.)

6679 TECHNIQUES OF METALS RESEARCH. VOLUME II. TECHNIQUES FOR THE DIRECT OBSERVATION OF STRUCTURE AND IMPERFECTIONS. PART I. Bunshah, R. F. (ed.). New York, John Wiley and Sons, Inc., 1968. 525p. $24.50.

Twenty papers are presented under the following topics: techniques for direct observation of structure and crystal imperfections, microscopic techniques, special techniques for study of plastic deformation and fracture, diffraction techniques, and autoradiographic techniques. (M.C.G.)

6680 ON THE INTERRELATIONSHIPS OF THE PHYSICAL PROPERTIES OF LANTHANIDE COMPOUNDS: THE MELTING POINT, HEAT OF FORMATION: AND LATTICE PARAMETERS. Gschneidner, K. A. Jr. (Ames Lab., Iowa). J. Less-Common Metals, 17: 1-12(Jan. 1969).

The relative heats of formation and the reduced melting temperatures (the melting point of the compound divided by the melting point of the metal) of lanthanide compounds are correlated with the magnitude of the lanthanide contraction in these compounds relative to the lanthanide contraction in the pure metals. If the lanthanide contraction (as determined from the lattice constants) in the compounds is greater than that observed for the metals, the heat of formation is expected to increase as one proceeds from lanthanum to lutetium. The opposite is expected if the lanthanide contraction is less in the compounds than in the metals. This was substantiated for the five series for which sufficient thermodynamic data exist, specifically, RCd, RCl_3, RH_2, RMg, and R_2O_3. For the melting points, 15 of 17 lanthanide compound series show agreement between the observed reduced melting points and that expected from the relative lanthanide contraction. Discrepancies are more likely to occur when correlating the melting points, since only part of the various bonds, RM, MM, and RR, are broken upon melting, than for the heats of formation since this quantity is a measure of forming all of the bonds in the crystal. (auth)

6681 SOLUBILITY OF OXYGEN IN LIQUID SODIUM. Beisswenger, H.; Dorner, S. (Kernforschungszentrums, Karlsruhe, Ger.). J. Nucl. Mater., 28: 297-302(1968).

The solubility of oxygen in liquid sodium was determined with a simplified amalgamation method in the temperature range from 130 to 480°C. A special sampling technique was developed which avoids any contact of the sodium with other material following filtration. By the amalgamation method the accuracy was improved and the mercury consumption considerably decreased. The temperature dependence of the measured saturation concentration c_s follows the formula $\log c_s = 4.908 - (1606/T)$, (T = abs. temperature), in the whole temperature range. Previous investigations reported markedly higher values of c_s in the lower temperature range which differ from the formula. This deviation was not observed in this study. The heat of solution Q of Na_2O in liquid sodium was calculated and found to be Q = 7.33 kcal/mole. (auth)

6682 GRAIN BOUNDARY HYDRIDE HABIT IN ZIRCALOY-2. Ambler, J. F. R. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 28: 237-45(1968).

In Zircaloy-2, grain boundaries lying in certain directions relative to the adjacent grains were found to be preferred sites for zirconium hydride precipitation. The most favorable sites are

those grain boundaries which make angles of 35 to 40° and 60 to 75° to the basal planes of the adjacent grains. (auth)

6683 DIFFUSION OF CHROMIUM AND IRON IN ZIRCALOY-2. Pande, B. M.; Naik, M. C.; Agarwala, R. P. (Bhabha Atomic Research Centre, Bombay). J. Nucl. Mater., 28: 324-32(1968).

Using the residual activity method, the diffusion of chromium and iron in alpha and beta Zircaloy-2 was studied in the temperature range of 650 to 1250°C. The temperature dependence of their diffusivities (in cm^2/sec) can be described as $D_{Cr/\alpha\ Zircaloy\text{-}2}$ (650 to 780°C) = 2.91×10^{-6} exp (−35,620 cal/RT), $D_{Cr/\beta\ Zircaloy\text{-}2}$ (980 to 1250°C) = 6.31×10^{-2} exp (−51,040 cal/RT) and $D_{Fe/\alpha\ Zircaloy\text{-}2}$ (650 to 780°C) = 2.56×10^{-5} exp (−27,110 cal/RT), $D_{Fe/\beta\ Zircaloy\text{-}2}$ (980 to 1250°C) = 1.03×10^{-2} exp (−46,767 cal/RT). A non-linearity in the Arrhenius plots was observed in the phase transition region (780 to 960°C). It was explained on the basis of the statistical average of the diffusivity in both the phases present at a particular temperature in the transition region. (auth)

6684 THERMAL CONDUCTIVITY OF PURE AND IMPURE TIN IN THE NORMAL AND SUPERCONDUCTING STATES. Reynolds, C. A.; Gueths, J. E.; Burckbuchler, F. V.; Clark, N. N.; Markowitz, D.; Pearson, G. J.; Bartram, R. H.; Ulbrich, C. W. (Univ. of Connecticut, Storrs). pp 257-8 of Thermal Conductivity. Flynn, Daniel R.; Peavy, Bradley A. Jr. (eds.). Washington, D. C., National Bureau of Standards, 1968.

From 7th Conference on Thermal Conductivity, Gaithersburg, Md. See NBS-SPEC.PUBL.–302; CONF-671110.

Measurements of the normal- and superconducting-state thermal conductivities (K^n and K^s) were made on two pure (99.999%) and twenty lightly doped tin specimens. Nine polycrystalline samples contained mercury, lead or bismuth impurity up to 1 at. %. Eleven single crystal samples containing up to 0.3 at. % cadmium were measured with the heat current nearly perpendicular to the tin tetrad axis. The lattice component in the normal state, K^n_g, is fractionally very small, but is enhanced in the superconducting state, K^s_g, the data admit to analysis in terms of the "universal curve" formalism of Lindenfeld and Pennebaker for, K^n_g, and the theory of Bardeen, Rickayzen and Tewordt for K^s_g/K^n_g. The electronic component in the normal state, K^n_e, is assumed to be of the conventional form $(\beta/T + \alpha T^2)^{-1}$. The ratio, ρ_0/β, where ρ_0 is the residual resistivity, is found to be independent of impurity content and in agreement with the theoretical Lorenz number. The anisotropy of β is found to be similar to that of ρ_0. The variation of α was studied as a function of impurity concentration and found to increase monotonically with concentration, as reported by previous investigators. A theory was formulated based on the effect of energy gap anisotropy on K^s_e. An expression was developed for K^s_e/K^n_e as a function of crystal orientation, temperature, and mean free path. The gap edge, which is central to thermal conductivity, is rendered isotropic by impurities well before their effect is felt on quantities such as the average gap or transition temperature. The theory is found to reproduce the qualitative features of our data, as well as that of Guenault for pure tin, but it underestimates the magnitude of the anisotropy effect by about a factor of two. From the isotropic theory of Kadanoff and Martin and Guenault's data the effective gaps parallel and perpendicular to the tin tetrad axis were estimated. Using the picture of the Fermi surface proposed by Klemens, the average gap after anisotropy has been washed out was calculated and it was found that the data are in good agreement with theory when the gap variation is determined in this semi-empirical way. (auth)

6685 THE THERMAL CONDUCTIVITY AND ELECTRICAL RESISTIVITY OF TUNGSTEN–26 WEIGHT PERCENT RHENIUM. Feith, A. D. (General Electric Co., Cincinnati). pp 371-80 of Thermal Conductivity. Flynn, Daniel R.; Peavy, Bradley A. Jr. (eds.). Washington, D. C., National Bureau of Standards, 1968.

From 7th Conference on Thermal Conductivity, Gaithersburg, Md. See NBS-SPEC.PUBL.–302; CONF-671110.

Radial heat flow measurements of the thermal conductivity of W-26Re (wt %) have been made at 300 to 2200°C. These data identify a small positive temperature coefficient on conductivity with conductivity values ranging from 56.0 $Wm^{-1}\,deg^{-1}$ at 300°C to about 69.0 $Wm^{-1}\,deg^{-1}$ at 2200°C. Electrical resistivity measurements are also reported for both W-26Re and for unalloyed tungsten. This information was employed to calculate the electronic contribution to the thermal conductivity of the W-26Re alloy. At 300°C the electronic contribution was calculated to be about 65% of the thermal conductivity, whereas at 2200°C the conductivity is about 90% electronic. (auth)

6686 THE STATE OF KNOWLEDGE REGARDING THE THERMAL CONDUCTIVITY OF THE METALLIC ELEMENTS. Powell, R. W.; Ho, C. Y. (Purdue Univ., West Lafayette, Ind.). pp 1-31 of Thermal Conductivity. Flynn, Daniel R.; Peavy, Bradley A. Jr. (eds.). Washington, D. C., National Bureau of Standards, 1968.

From 7th Conference on Thermal Conductivity, Gaithersburg, Md. See NBS-SPEC.PUBL.–302; CONF-671110.

The program of the Thermophysical Properties Research Center has since its inception included the extraction, evaluation, and publication of all thermal conductivity data that have been combed from a major portion of the world literature. The values so derived for many metallic elements have now been critically assessed. Some examples are presented which indicate the problems involved in arriving at probable thermal conductivity values from the limited information. Much more work is still required, and the elements and temperature ranges are clearly indicated for which the investigation shows the need for additional measurements. A first measurement has yet to be reported for 19 metals. The provisional recommendations are presented as logarithmic plots of thermal conductivity against temperature. (auth)

6687 ELASTIC PROPERTIES OF Pu IN ϵ PHASE. Cornet, J. A.; Bouchet, J. M. (CEN FAR, Fontenay-aux-Roses, France). J. Nucl. Mater., 28: 303-10(1968). (In French).

The ultrasonic resonance method was used to determine the elastic constants of polycrystalline plutonium up to its melting point. Special attention was devoted to the ϵ phase, and are determined (up to 520°C) its Poisson ratio ($\sigma = 0.2 \pm 0.02$), Young's modulus ($E = 1106 \times 10^7$ N/m^2 at 430°C) and the temperature coefficient of the modulus ($dE/dT = (-0.40 \pm 0.03)\ 10^8$ $N/m^2 \cdot °C$). From these values the compressibility was deduced and compared with a theoretical value calculated from a new expression for Grüneisen's constant; conclusions concerning the diffusion mechanism in this bcc phase were drawn. (auth)

6688 X-RAY DIFFRACTION STUDIES OF THE EFFECTS OF DEFORMATION ON NIOBIUM ALLOYS CONTAINING TITANIUM, VANADIUM, AND ZIRCONIUM. Penney, J.; Hoff, W. D.; Kitchingman, W. J. (Univ. of Manchester, Eng.). J. Phys., D (London), 1: 1645-50(Dec. 1968).

The effects of deformation by filing on bcc niobium-based alloys were investigated. The broadening of the x-ray powder diffraction line profiles was interpreted by Fourier analysis, and the results are reported in terms of particle size, strain, faulting probability, and dislocation density. The results were derived using two calculation procedures for the application of Warren's (1959) method. It is concluded that faulting is not of major importance in the deformation process in these alloys. The particle size and dislocation density show systematic variation with composition. (auth)(UK)

6689 VARIATION OF THE CRITICAL SHEAR STRESS FROM VARIOUS METHODS OF SLIPPAGE IN MONOCRYSTALS OF α URANIUM DEFORMED BY COMPRESSION AS A FUNCTION OF TEMPERATURE (BETWEEN 20 AND 650°C). Daniel, John S.; Le Floch, Andre; Jean-Louis, Francois; Lacombe, Paul (Faculte des Sciences, Orsay, France. CNRS, Paris). Compt. Rend., Ser. C, 267: 1103-6(Oct. 28, 1968). (In French).

The deformation of monocrystals of α-uranium by compression makes possible the determination with more precision the variation in the critical shear stress from various methods of slippage (010)[100], (001)[100], (110)[$1\bar{1}0$], and (021)[$1\bar{1}2$] as a function of the temperature (from 20 to 600°C). In addition, a slippage (021)[100] was discovered, active only at high temperature (>500°C). These experimental results support the hypothesis based on the theory of elastic anisotropy. (tr-auth)

6690 DIFFUSION OF INTERSTITIAL HELIUM IN TANTALUM. Verdini, Livio (Istituto Nazionale di Ultracustica, Rome). Ric. Sci., 38: 411-17(May 1968).

By measurements of the elastic energy dissipation as a function of temperature and frequency parameters of the diffusion of interstitial helium in tantalum were obtained. The specimen, after a preliminary annealing treatment in vacuum, was kept in helium atmosphere at 800°C for a few hours. This treatment introduced a peak in the dissipation curve located at 87°K for a vibration frequency of 29 kc/sec. The activation energy of the process, calculated either by the shape of the single peaks or by the shift of the peak with frequency, is W = 0.05 eV and the diffusion constant is $D_0 = 4.4 \times 10^{-10}$ cm^2/s. (auth)

Structure and Phase Studies

Refer also to abstracts 6241, 6664, and 6747.

6691 (UCRL–50509) ELECTRON PROBE MICROANALYSIS OF THE PLUTONIUM–LEAD ALLOY SYSTEM. Nickerson, Robert F. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 23, 1968. Contract W-7405-eng-48. 20p. Dep. CFSTI.

The electron probe microanalyzer was used to determine the

chemical compositions of the many phases that exist in the plutonium–lead binary alloy system. Probe analysis helped to identify these phases as having the following stoichiometries: Pu_3Pb, Pu_5Pb_3, Pu_5Pb_4, Pu_4Pb_5, $PuPb_2$, and $PuPb_3$. The applicability of the Ziebold–Ogilvie empirical method for quantitative analysis of this system was established and its applicability to similar systems where no standards are available is also shown. (auth)

6692 A SIMPLIFIED METHOD OF QUANTITATING PREFERRED ORIENTATION. Klenck, Michael M. (Atomics International, Canoga Park, Calif.). Advan. X-Ray Anal., 11: 447-53 (1968).

From 16th Annual Conference on Applications of X-Ray Analysis, Denver, Colo. See CONF-670813.

Qualitative evaluation of preferred orientation in 10-mil Hastelloy N seamless tubing was carried out by obtaining conventional pole figures for several samples with the modified Schulz reflection technique. This established the texture as a (110)[112]. Quantitative determination of this texture was achieved for a large number of samples by a radial traverse of an azimuthally averaged (110) stereographic projection. This was accomplished with a Schulz goniometer by rotating the sample rapidly in its own plane while slowly varying the tilt angle ϕ. The first minimum observed in the resultant pattern approximates the pole density of the randomly oriented component of the sample. A scan obtained from a randomly oriented sample and suitably scaled to match pole density at these minima serves to distinguish the random from the oriented component of the sample. A ratio of the oriented to the random component as a function of the tilt angle ϕ is independent of the instrumental effects of defocusing and absorption. This ratio is proportional to the pole density of the oriented component since the pole density of the random component is a constant by definition. The same constant of proportionality yields a pole density of unity for the random component. Integrating the pole density for the random component over the surface of a reference sphere of unit radius gives the value 4π for the number of randomly oriented poles N_R. The method entails about 30 min of an analyst's time and 40 to 120 min of machine time, depending on the grain size of the sample. Further information on the angular breadth of the texture may be obtained from the plot of the integrand. This technique is subject to the limitations that the material have a single texture and it must be possible to prepare the specimens so that a suitably chosen pole figure contains a central concentration of poles which are delineated from other regions of pole concentration by a surrounding minimum in pole density. This is generally not too difficult in the case of sheet textures but requires that the specimen normal be parallel to the fiber axis for a fiber texture. (auth)

6693 THE LAVES PHASE IN Co–Ni–Nb TERNARY ALLOYS. Varli, K. V.; D'yakonova, N. P.; Ladikova, N. P.; Umanskii, Ya. S. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met., No. 6, 98-102(1967). (In Russian).

Alloys located in two sections of the ternary diagram Co–Ni–Nb: from the phase Co_2Nb to the alloy corresponding to the compound Ni_2Nb (section 1) and from Co_2Nb to the phase Ni_3Nb (section 2) were investigated. The alloys were melted in an argon furnace and their specimens were than homogenized at 1175 and 1075°C for 100 hr and subsequently subjected to x-ray micrographic and microscopic analyses as well as to hardness measurements. In the Co–Ni–Nb system there exists the Laves $(Co, Ni)_2Nb$ phase of the $MgCu_2$ type. The region of its existence over the section Co_2Nb–Ni_2Nb (section 1) includes 47 at. % Ni, and over the section Co_2Nb–Ni_3Nb (section 2), 42 at. % Ni. The decrease in the lattice constant and microhardness of the phase Co_2Nb with increase in the Ni content of the alloy is due to the formation of the Co_2Nb-based solid solution of Ni. The increase in the lattice constant and microhardness of the phase $(Co, Ni)_2Nb$ with further increase in the Ni content of the alloy may be due to the segregation of $(Ni, Co)_3Nb$. The maximum Ni content in the Laves phase such that the lattice constants of that phase vary in accordance with the Vegard rule, corresponds to the formula $(Co_{0.83}Ni_{0.17})_2Nb$. The phase $(Ni, Co)_3Nb$ was detected in the alloys containing more than 6 at. % Ni over section 1 and (according to tentative findings) more than 7 at. % Ni over section 2. In addition to the phase Ni_3Nb the phase Ni_7Nb_6 also exists in the alloys containing more than 46 at. % Ni over section 1 as well as 42 to 66 at. % Ni over section 2. (ATD)

6694 SOME METALLOGRAPHIC TECHNIQUES APPLIED TO MOLYBDENUM SINGLE CRYSTALS. I. A NEW ELECTROLYTIC ETCHANT FOR DISLOCATIONS IN MOLYBDENUM. Das, Gauri C. (Imperial Coll. of Science and Tech., London). Prakt. Metallog., 5: 199-205(Apr. 1968). (In German and English).

A new electrolytic etchant for molybdenum has been described. Precautions in preparation have been noted. Examples are used to illustrate reliability and uses of the etchant. Its characteristics are shown to be advantageous over those of past etchants. (auth)

6695 A METALLOGRAPHIC STUDY OF SOLIDIFICATION AND SEGREGATION IN CAST ALUMINUM–URANIUM ALLOYS. Bramfitt, Bruce L.; Leighly, H. P. Jr. (Univ. of Missouri, Rolla). Metallography, 1: 165-93(Nov. 1968).

The micromorphology and type of segregation in vacuum-cast ingots of aluminum–uranium alloys, ranging from 5 to 30 weight percent, were studied. The microstructural characteristics are similar to those of aluminum–silicon alloys of the same composition range, except that the aluminum–uranium eutectic was identified as having "chevron" and "rhombic spiral" types of morphology. (auth)

6696 ON THE STACKING SEQUENCE IN LANTHANIDE METALS AND ALLOYS ADOPTING FAMILIES OF POLYMORPHIC STRUCTURES: POSSIBLE INFLUENCE OF 4f ELECTRONS. Gschneidner, K. A. Jr. (Iowa State Univ., Ames); Pearson, W. B. Mater. Res. Bull.,, 3: 951-62(Dec. 1968).

Families of crystal structures that can be generated by stacking together identical layers, or groups of layers of atoms in different regular sequences have little difference in free energy between one structure type and another. Factors influencing the choice of structure among members of such families are examined in elemental lanthanons and their LnM_3 and Laves phase compounds. Some evidence is found that the 4f electrons influence the choice of structure type. (auth)

6697 CONSTITUTION OF PLUTONIUM-RICH PLUTONIUM–HAFNIUM ALLOYS. Ellinger, F. H.; Land, C. C. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater., 28: 291-6(1968).

The phase equilibria of plutonium–hafnium alloys in the composition range 0 to 10 at. % Hf were investigated by the methods of x-ray diffraction, microscopy, dilatometry and thermal analysis. The maximum solubilities of hafnium in ϵ Pu and δ Pu were found to be about 7 at. %, in δ' Pu about 1 at. %, and in γPu and βPu less than 0.5 at. %. Both the δ and β phases can be retained to room temperature in a metastable condition. Two plutonium-rich intermediate phases are formed peritectoidally: (1) the ζ phase at about 3 at. % Hf and 270°C by the reaction $\gamma Pu + \theta \rightleftharpoons \zeta$, and (2) the θ phase at about 6.5 at. % Hf and 341°C by the reaction $\delta Pu + \alpha Hf \rightleftharpoons \theta$. Both intermediate phases appear to be stable at room temperature. (auth)

6698 ANALYSIS OF FIELD-ION MICROGRAPHS: STACKING FAULTS IN TUNGSTEN. Smith, D. A.; Bowkett, K. M. (Univ. of Cambridge, Eng.). Phil. Mag., 18: 1219-34(Dec. 1968).

It is shown how the images of stacking faults in bcc metals can be analyzed in field-ion micrographs. The method of analysis is applied to some observations in tungsten. A mixed dislocation lying close to the [142] direction and with Burgers vector $a/2[11\bar{1}]$ is shown to have dissociated twice. The dislocation dissociated on {110} planes in accord with either the dissociation proposed by Cohen–Crussard or that proposed by Wasilewski–Foxall. A tentative value for the stacking-fault energy of tungsten of $\gamma \simeq$ 50 ergs cm^{-2} is obtained, in the suspected presence of some impurity segregation. (auth) (UK)

6699 MICROSTRUCTURE OF A CERIUM, COBALT, AND COPPER ALLOY WITH A HIGH COERCIVITY. Senno, Harufumi; Tawara, Yoshio (Matsushita Electric Industrial Co., Ltd., Osaka). Jap. J. Appl. Phys., 8: 118(Jan. 1969).

$(CeCo_5)_{0.8}(CeCu_4)_{0.2}$ specimens were annealed at 600°C and subjected to microscopic examination and x-ray microanalysis. The microstructure showed a texture of network-like etch patterns. The microanalysis showed that regions rich in Cu and Ce were poor in Co; the etched parts correspond to these regions. It is suggested that Cu- and Ce-rich precipitates play an important role in the magnetic hardening mechanism of the alloy. (D.L.C.)

6700 ZIRCONIUM–NIOBIUM–COBALT SYSTEM. Bataleva, S. K.; Kuprina, V. V.; Burnashova, V. V.; Markiv, V. Ya. Vestn. Mosk. Univ., Ser. II. Khim., No. 5, 48-53(Sept.-Oct. 1968). (In Russian).

Isothermal section for Zr–Nb–Co system (at 800°C) was plotted. (auth)

6701 ELASTIC ANISOTROPY OF CRYSTALS. Chung, D. H.; Buessem, W. R. (Pennsylvania State Univ., University Park). pp 217-45 of Anisotropy in Single-Crystal Refractory Compounds. Vol. 2. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio. See CONF-670637-(Vol.2).

The elastic anisotropy of a crystal is the orientation-dependence

of the elastic moduli or sound velocities. A convenient method of describing the degree of elastic anisotropy in a given cubic, hexagonal, trigonal, and tetragonal crystal is discussed with its practical values. For a cubic crystal the degree of elastic anisotropy has been defined as $A^*_{cubic} = 3(A-1)^2/[3(A-1)^2 + 25\,A]$, where A is the usual anisotropy factor given by $A = 2c_{44}/(c_{11} - c_{12})$. A^* is zero for the crystals of the elastic isotropy (i.e., A = 1) and for an anisotropic crystal A^* is a single-valued measure of the elastic anisotropy regardless of whether A > 1 or A < 1. It was shown that A^* gives a relative magnitude of the actual elastic anisotropy possessed by a crystal. Definitions of the degree of elastic anisotropy for hexagonal, trigonal, and tetragonal crystals are presented and practical implications discussed and tabulated. Examples are made with a number of crystals, ranging from simple metals and alloys to oxides, borides, carbides, halides, fluorides, sulfides, selenides, and tellurides. (auth)

6702 STRUCTURE PROPERTIES OF POLYCRYSTALLINE ZIRCONIUM AND GRAIN GROWTH. Dechamps, Michel; Debuigne, Jean; Lehr, Pierre (Research center of Metallurgical Chemistry, Vitry-sur-Seine, France). Metaux (Corros.-Ind.), No. 517, 305-29(Sept. 1968). (In French).

The structural characteristics of polycrystalline zirconium are analyzed and the phenomenon of grain growth is studied. In order to analyze the criteria conditioning grain growth, which results in an intrinsic structural instability, the geometric and morphological characteristics of polycrystalline aggregates were analyzed quantitatively. The statistical distribution law of the grains in the plan was established as a function of their number of sides. There is a statistical relation between the mean diameter of the grains and their form with the mean diameter of the grain varying linearly with the number of sides. The real structure of the polycrystalline metal does not possess the properties of an ideal assemblage of polyhedrons of the tetrakisdecahedron or dodecahedron type. The statistical distribution law of the junction angles at the triple points was analyzed in each grain category, characterized by a given number of sides. The mean value of the angles to the grain peaks increases with the number of sides. The variation law of the mean value of the angles to the peaks was studied as a function of the number of grain sides. The study of the structural characteristics on the statistical plane has shown the causes of instability of the granular structures. The majority of the grain boundaries have a curvature. Because of the intergranular tension forces, these grain boundaries tend to be displaced in the direction of their center of curvature at a rate inversely proportional to the value of the radius of curvature. The triple points, to a high degree, are not in equilibrium. Each grain does not belong definitively to a given class because during the structural evolution its number of sides can be modified. The direct observation of the structural evolution phenomenon of recrystallized Zr was made with a heating stage microscope operating in a vacuum below 10^{-6} torr. (tr-auth)

6703 STUDY ON THE RETURN FROM THE ORTHORHOMBIC METASTABLE PHASES OF URANIUM–TITANIUM ALLOYS CONTAINING 4.8 AND 9.5 PERCENT TITANIUM. Baschwitz, R.; Colombie, M.; Foure, M. (CERCA, Romans sur Isere, France). J. Nucl. Mater., 28: 246-56(1968). (In French).

Annealing of metastable phases, obtained by quenching from the gamma domain U–Ti alloys containing between 4.8 and 9.5 at. % of titanium, was studied by micrography, hardness measurement, microhardness measurement, and by x-ray diffraction, with a view to comparing the behavior of these alloys with that of U–Mo and U–Nb alloys. In contrast with the behavior of U–Mo and U–Nb alloys, the annealing behavior of α'_s and α'_t phases of the U–Ti alloys are qualitatively identical; the banded phases in the U–Ti alloys do not give rise to the precipitation of an equilibrium phase. For structures in the system U–Ti, a classical process of precipitation-hardening is observed, followed by direct precipitation of the stable compound. This important difference from U–Mo and U–Nb alloys is taken to be due to the presence of the intermetallic compound U_2Ti. A consequence of this is that the α'_t phase richer in titanium produces a very high hardness maximum which is distinctly higher than that associated with acicular structures with a smaller solute content. Recrystallization was observed during the 4th stage of annealing of these alloys, which appears to be related to the second recrystallization observed by May in U–Mo alloys with a banded structure. It was not possible to confirm the phenomenon of solution and reprecipitation of the second phase at the transformation front. On the contrary, it seems that the precipitates of U_2Ti are related in orientation to the original gamma structure and not with the new alpha structure. (auth)

Radiation Effects

Refer also to abstracts 6637, 6652, 6663, 6665, 7041, and 7398.

6704 (GEMP-644) COMPUTER SIMULATION OF POINT DEFECT ANNEALING IN METALS. Besco, David G. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.). Oct. 1967. 81p. Dep. CFSTI.

A method is outlined for directly simulating on a digital computer the annealing of point defects produced by irradiation or quenching. The properties of a general annealing simulation model are defined, and a particular model is developed for the isothermal annealing of neutron-irradiated α-iron near room temperature, based on experimental data. A FORTRAN program which implements this model is described in detail. (auth)

6705 (GEMP-1004, pp 89-177) RADIATION EFFECTS ON FAST REACTOR CLADDING AND STRUCTURAL MATERIALS. Moteff, J.; Kingsbury, F. D.; Smith, J. P. (General Electric Co., [Cincinnati, Ohio]. Nuclear Materials and Propulsion Operation).

The effect of radiation on the time-, temperature-, and stress-dependent properties of selected heat-resistant alloys and refractory metals was determined. Causes of property changes were identified and remedial measures are planned. Materials investigated include A-286 Iron alloy; Hastelloy X; Hastelloy N; Hastelloy R-235; Al–Cr–Fe–Y alloys; AISI 304, 316, and 348 stainless steels, ASTM-A 302B and A 350-LF3 pressure vessel steels, and various Inconel and Incoloy alloys and heat-resisting metals such as Mo, Nb, Ta, V, and W. (F.S.)

6706 STUDY OF GAS BEHAVIOR DURING ANNEALING OF IRRADIATED HOT PRESSED BERYLLIUM. Guseva, T. M.; Davydov, E. F. At. Energ. (USSR), 25: 152-3(Aug. 1968). (In Russian).

Be samples were given fast neutron doses of 2×10^{21} and 1.0×10^{22} neutrons/cm^2. Isothermal annealing of the samples was then carried out at 400, 500, and 600°C. The maximum rate of gas evolution was noted at ~500°C, where the first stages of recrystallization are beginning to take place in Be metal. The gas concentrates at the grain pores and migrates out. For Be given a fast neutron dose of 2.0×10^{21} neutrons/cm^2 the sample density decreased from 1.80 to 600°C to 1.19 g/cm^3 at 900°C due to swelling of the Be. The Be sample given a higher fast neutron dose of 1.5×10^{22} showed no change in density on annealing up to 1000°C. The Be lattice has only a limited capacity for holding helium gas. At T > 600 to 700°C the helium gas is evolved in the process of formation. (TTT)

6707 NEUTRON EMBRITTLEMENT OF TWO AUSTENITIC IRON-BASE-ALLOYS AT ELEVATED TEMPERATURES. I. INFLUENCE OF ALLOY-TYPE AND HEAT ANALYSIS. Garzarolli, F.; Francke, K. P.; Fischer, J. (AEG-Telefunken, Berlin). J. Nucl. Mater., 28: 280-90(1968).

Iron-base-alloys containing nickel and chromium like XCrNiMoNb 1616* and XCrNi 2030* were irradiated up to 1.4×10^{20} n/cm^2 (E > 1 MeV) at 650°C and changes due to neutron irradiation in tensile and stress rupture characteristics at 300 and 650°C were established. In tensile testing an obvious decrease in 650°C-total elongation was noticeable which may be explained by a weakening of grain boundaries by helium bubble formation. The decrease in stress rupture strength of XCrNiMoNb 1616 is mainly based upon heavy increase of the secondary creep rate whereas in XCrNi 2030 alloys the grain boundary weakening seems to be more important for this reduction. For both alloy types a superiority of commercial heats over high purity qualities can be reported generally. (auth)

6708 OBSTACLES RESPONSIBLE FOR THE HARDENING OF NEUTRON-IRRADIATED COPPER CRYSTALS. Makin, M. J. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag., 18: 1245-56(Dec. 1968).

A critical analysis was made on both the experimental evidence on the deformation characteristics of neutron-irradiated copper crystals and the hardening models proposed. It is shown that the observed behavior is explicable only in terms of the presence in as-irradiated crystals of a spectrum of thermally activated obstacles with values of F_{max} of μb^2 and greater. During annealing the obstacles with the smallest values of F_{max} are removed first, resulting in the formation of a low-temperature 'athermal' region in the flow stress–temperature curve with deformation characteristics similar to those observed in crystals containing very hard second-phase particles. The conclusion of Koppenaal and Arsenault (1965) that only a single type of thermally activated obstacle exists in irradiated copper is shown to be incorrect. Fleischer's (1962) theory, as applied to irradiation hardening, is criticized. (auth) (UK)

6709 ELECTRON MICROSCOPE OBSERVATIONS ON THE DISLOCATION ARRANGEMENT IN DEFORMED COPPER SINGLE CRYSTALS IN THE STRESS-APPLIED STATE. Mughrabi, H.

(Max-Planck-Institut fuer Metallforschung, Stuttgart). Phil. Mag., 18: 1211-18(Dec. 1968).

The dislocation arrangement in the stress-applied condition of copper single crystals deformed in tension at 78°K was pinned by irradiating with a dose of 10^{18} n/cm^2 fast neutrons at 4.2 or 20°K. Transmission electron microscope studies of the primary glide plane showed that significant differences exist between the dislocation arrangements in the stress-applied and in the stress-removed state of the crystals, indicating considerable dislocation rearrangement during unloading. In particular, dislocation groups and pile-ups consisting of 10 to 20 dislocations of the same sign were observed in stage II in the stress-applied state. (auth) (UK)

6710 EFFECT OF NEUTRON IRRADIATION ON THE LOSS AND REARRANGEMENT OF DISLOCATIONS IN THIN FOILS OF FATIGUE-HARDENED COPPER. Hancock, J. R. (Midwest Research Inst., Kansas City, Mo.). Contract AF 33(615)-3987. Phil. Mag., 18: 1235-44(Dec. 1968).

Dislocation densities and arrangements in foils sectioned parallel to the primary slip plane were found to be the same, within experimental error, for both neutron-irradiated and unirradiated fatigue-hardened copper crystals. The loss of dislocations from unirradiated foils sectioned perpendicular to the primary slip direction was substantial (approximately 70%) for crystals in the early stages of fatigue hardening. The evidence from these experiments supports the conclusion that primary screw dislocations were mutually annihilated by cross-slip during cyclic hardening. (auth) (UK)

6711 INTERNAL FRICTION MEASUREMENTS IN GOLD AFTER LOW TEMPERATURE ELECTRON IRRADIATION. Jordan, M. R.; Lomer, Jenifer N. (Univ. of Reading, Eng.). Phil. Mag., 18: 1161-74(Dec. 1968).

The change in friction as a function of the total integrated electron flux was measured at 80 and 280°K for an electron energy of 2 MeV. The results can be explained in terms of dislocation pinning if there are at least two dislocation systems present. After irradiation near 15°K, little or no direct pinning was observed, but on annealing continuous pinning was observed between 25 and 75°K. Pinning also occurred in the temperature ranges 170 to 220, 240 to 260, and 280 to 320°K on warming up after irradiations at 80°K. These pinning stages were superimposed on a background of depinning. The ratio of the number of defects reaching the dislocations during the first two pinning stages depended on the electron energy. The results are compared with those found in copper, and the similarity suggests that the nature of the irradiation damage is the same in both metals. (auth) (UK)

Ceramics and Cermets

Refer also to abstracts 6270 and 6629–6632.

6712 ANISOTROPY IN SINGLE-CRYSTAL REFRACTORY COMPOUNDS. VOLUME 1. Proceedings of an International Symposium held June 13–15, 1967, Dayton, Ohio. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968. 421p. (CONF-670637-(Vol.1)).

A total of 20 papers is included in volume 1. Separate abstracts were prepared for 13 of the papers. Topics covered by the papers include transition-metal carbides, borides, nitrides, and silicides; crystallography; electronic structure and bonding; phase relations; and physical-chemical properties. (D.L.C.)

For abstracts of individual papers see: 6676, 6677, 6731, 6733, 6735, 6753–6757, and 7050–7052.

Corrosion and Erosion

Refer to abstract 6634.

Preparation and Fabrication

Refer also to abstracts 6726, 6728, and 6965.

6713 (BARC–323) STUDIES ON SINTERING OF BERYLLIA. PART IV. MECHANISM OF SINTERING DURING HOT PRESSING OF BERYLLIA. Moorthy, V. K.; Bhat, R. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 21p. Dep.

Beryllium oxide obtained by calcination of $Be(OH)_2$ at various temperatures was hot pressed at different temperatures and pressures. The densities obtained depended on the calcination temperature and increased directly with an increase in either the hot pressing temperature or pressure. The data are in accord with McClelland's equation; both the yield stress and activation energy are enhanced with an increase in calcination temperature. It thus appears that the densification during hot pressing of active BeO powders is due to macroscopic material movement (plastic flow) and is directly dependent on the crystallinity of the powder. (auth)

6714 (BARC–346) KINETICS OF SINTERING OF UO_2. Moorthy, V. K.; Soni, N. C. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 19p. Dep.

A study was made on the kinetics of sintering of pellets prepared from UO_2 powders at different calcination temperatures. The powders were calcined between 500 to 1500°C and the densification characteristics of the pellets made from these were evaluated for different soaking times from 10 to 1000 mts at sintering temperatures between 1000 and 1500°C. Data were analyzed using the empirical equation $D = C + K \log t$, where D is the density, C and K constants, and t time. It was found that the progress of sintering, attainment of limiting densities, and variation in rates of densification at different temperatures and time can be explained on the assumption that material movement (hence densification) is governed by the number, nature, and energy of crystalline defects (flaws) in the original powders. (auth)

6715 (ORNL–4324) COATED-PARTICLE FUELS. Godfrey, T. G.; Beatty, R. L.; Scott, J. L.; Coobs, J. H.; Prados, J. W.; Overholser, L. G.; Ferris, L. M. (Oak Ridge National Lab., Tenn.). Nov. 1968. Contract W-7405-eng-26. 142p. Dep. CFSTI.

Information was surveyed on fabrication, characterization, performance, and reprocessing plutonium, thorium, or uranium coated-particle fuels with emphasis on pyrolytic carbon-coated oxides and carbides. Processes used in fabrication include powder rolling and sintering, particle melting and sol-gel. Properties of pyrolytic-carbon coatings and their dependency on coating conditions are discussed. Radiation effects on mechanical properties and dimensional changes and fission product retention behavior are given. The burn-leach and grind-leach processed for fuel reprocessing are described. (F.S.)

6716 DRY-PRESSING OF A URANIA PYCNOMETER. White, David E.; Beals, Robert J. (Argonne National Lab., Ill.). J. Amer. Ceram. Soc., 51: 666-7(Nov. 21, 1968).

A urania pycnometer was fabricated for containing liquid uranium for density measurements. The dry-pressing method used to fabricate the pycnometer from UO_2 powder is described. (D.L.C.)

6717 QUALITATIVE METALLOGRAPHY OF URANIUM–PLUTONIUM MIXED CARBIDE FUELS. Bender, J. H. (Los Alamos Scientific Lab., N. Mex.). Metallography, 1: 19-24(Sept. 1968.

A metallographic technique that distinguishes between the metallic, dicarbide, and sesquicarbide phases and precipitates of plutonium silicide in sintered uranium–plutonium carbide fuels is described. This includes general sample preparation, the multiple techniques required, and the interpretation of results. (auth)

6718 THE OXIDATION OF UC AND UN POWDER IN AIR. Ohmichi, Toshihiko; Honda, Toshio (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo), 5: 600-2 (Nov. 1968).

Gravimetric measurements on the kinetics of the oxidation of UC and UN powder in air show that the complete conversion to U_3O_8 takes place by progressive mild oxidation below 300°C, marked increase of the rate of wt gain accompanying exothermic reactions, and the final oxidation. Oxidation of UC is diffusion controlled, but the oxidation of UN is a surface reaction. (F.S.)

6719 METALLOGRAPHY OF METAL-CARBIDE/CARBON-COATED FUEL PARTICLES. Cochran, Fred Lloyd; Knipping, J. E. (Gulf General Atomic Inc., San Diego, Calif.). Prakt. Metallog., 5: 138-43(Mar. 1968). (In German and English).

A technique for preparing (Th, U)C_2 fuel particles coated with metalcarbide and graphite for optical microscopy, using a metal-mesh wheel, is described. The technique is applicable to both preirradiation and postirradiation analysis. (auth)

6720 CHANGES IN THE SURFACE REGION OF METALLOGRAPHICALLY PREPARED SPECIMENS. Ondracek, Gerhard; Ludwig, Uta (Kernforschungszentrum, Karlsruhe, Ger.). Prakt. Metallog., 5: 369-75(July 1968). (In German and English).

Grinding and polishing removes the top layers from the specimen. The resulting surface suffers from fragmentation scratches and relief formation. The depth of these blemishes was measured as a function of abrasive grain size. Whereas on ceramic materials (Al_2O_3, MgO, UO_2), a relief is predominantly formed, metals (Al, Cu, Mo) become scratched. Scratch and relief depths show a different dependence on abrasive grain size. Some methods of avoiding fragmentation are briefly described. (auth)

6721 METHOD FOR PREPARATION OF URANIA SOLS. (to United States Atomic Energy Commission). British Patent 1,135,098. Nov. 27, 1968. Priority date Oct. 12, 1965, United States.

A method for preparing stable sols of UO_2 for use in nuclear fuels is described. Hydrous UO_2 is precipitated from an aqueous uranous nitrate by the addition of an alkaline reagent such as ammonium hydroxide at a pH of 6.0 to 7.3 under a non-oxidizing atmosphere. After filtering and washing, the UO_2 is peptized to form a stable sol by heating at 60 to 80°C under a non-oxidizing atmosphere until liquefied. (F.S.)

6722 OXYCARBIDE PHASES OF TANTALUM. Dubrovskaya, L. B.; Alyamovskii, S. I.; Shveikin, G. P.; Gel'd, P. V. Zh. Neorg. Khim., 13: 2331-9(Sept. 1968). (In Russian).

Results of investigations of special binary systems Ta–O and Ta–C were previously presented. It is noted that in both systems the following stable phases were shown: solid solutions of O, and C in Ta_2O_5 and hexagonal Ta_2C (β) and cubic TaC (γ) carbides. The latter possess noticeable fields of homogeneity: β-$TaC_{0.43-0.50}$ and γ-$TaC_{0.73-0.96}$ at 2200°C. For clarification of the possible existence of tantalum oxycarbides, several series of three-component mixtures of different composition were prepared. Hexagonal forms of oxycarbides were prepared by sintering mixtures of Ta, Ta_2O_5, and $TaC_{0.50}$ in an atmosphere of argon and purified helium. Cubic oxycarbides were prepared by sintering briquetted mixtures of Ta, Ta_2O_5, and $TaC_{0.82}$ of Ta_2O_5 and nC (n = 1 to 6) in CO or treatment of powdered Ta with CO. The phase composition of the products obtained was controlled roentgenographically. In addition, all of the final products were subjected to chemical analysis. Densities of the compounds were determined by the vacuum pycnometric method. Characteristics of 41 samples prepared by this method are given. (tr-auth)

6723 GROWTH AND PROPERTIES OF Nb_2O_5 THIN FILM CAPACITORS. Brunner, H. R.; Emmenegger, F. P.; Robinson, M. L. A.; Roetschi, H. (Labs. RCA, Ltd., Zurich). J. Electrochem. Soc., 115: 1287-9(Dec. 1968).

Halogen transport reactions were used to prepare thin films of Nb_2O_5, Ta_2O_5, TiO_2, and ZrO_2. The potential of Nb_2O_5 as a thin film capacitor was studied. The films suffered from low breakdown voltage. (M.C.G.)

Properties Evaluations

Refer also to abstracts 6070, 6143, 6144, 6667, 6675, 6676, 6715, 6723, 6753, 6755, 7051, and 7396.

6724 (GA–6889) ADVANCED BERYLLIUM OXIDE CONCEPTS. Quarterly Progress Report for the Period Ending December 31, 1965. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Jan. 29, 1966. Contract AT(04-3)-187. 49p. Dep. CFSTI.

The development of the dispersion fuel using beryllium oxide as the matrix, the development of the design for the test module for EBOR, and conceptual design of fuel elements using the ceramic materials were investigated. (J.C.W.)

6725 (GEMP–1004, pp 369-78) HIGH-TEMPERATURE RESEARCH ON CARBIDES FOR FUEL AND STRUCTURAL APPLICATIONS. White, J. F.; Juenke, E. F. (General Electric Co., [Cincinnati, Ohio]. Nuclear Materials and Propulsion Operation).

High temperature physico-chemical properties of refractory carbides for fuel and structural use were determined. Density and phases of vacuum hot pressed HfC, TaC, and ZrC are tabulated and the diffusion coefficients, lattice parameters, and thermodynamic properties of TaC and UC are given. (F.S.)

6726 (LA–3981) THE MANUFACTURE AND PROPERTIES OF AN EXTRUDED, RESIN-BONDED GRAPHITE, CMF-13 LOT AAQ1. Smith, Morton C. (Los Alamos Scientific Lab., N. Mex.). July 1968. Contract W-7405-eng-36. 55p. Dep. CFSTI.

CMF-13 Lot AAQ1 is a relatively large sample of an extruded, resin-bonded graphite. It was manufactured from commercial raw materials, which are fully characterized, and using standard procedures, which are described in detail. The principal physical and mechanical properties of the finished graphite are listed, in most cases as functions of temperature. (auth)

6727 COMMENTS ON THE EVALUATION OF THE MICROHARDNESS OF HIGHLY ELASTIC MATERIALS. II. Findeisen, Bernd; Illgen, Lothar (Forschungsinstitut fuer Metallische Spezialwerkstoffe, Dresden). Prakt. Metallog., 5: 186-98(Apr. 1968). (In German and English).

The evaluation of microhardness impressions using interference microscopy in conjunction with measurement of the diagonal in interference contrast for uncoated specimens and in bright field for coated specimens gives additional information about the plastic elastic behavior of highly elastic materials. The elastic contraction on removal of the load can be measured both diagonally and vertically. The residual depth, or diagonal size are dependent on the particular structure enabling conclusions regarding their material properties to be drawn. (auth)

6728 CHARGE TRANSIENTS IN ALUMINUM–SILICON NITRIDE–SILICON CAPACITORS. Hutchins, Charles Leroy. Raleigh, N. C.; North Carolina State of the Univ. of North Carolina, 1968. 174p.

Thesis.

Capacitors were fabricated on n-type Si substrates using thin films of SiN and filament evaporated Al. The SiN films were prepared using pyrolytic deposition of SiH_4 and NH_3 in an excess H atmosphere. The transient effects of the semiconductor surface charge in the MNS capacitors were investigated with temperature as a parameter. A theoretical model was developed to describe this charge motion within a limited time period. This period was chosen because it is a convenient time interval for experimental measurements and the theory simplifies greatly. During this time period, the trapped charge in the insulator is being released with little or no retrapping. The model proposes two types of trap distributions with respect to energy below the conduction band in the insulator. In an amorphous insulator the traps are assumed to be uniformly distributed. In an insulator which has small regions of crystallinity, the distribution is assumed to be exponential. The time dependence of two separate groups of MNS capacitors was found to match qualitatively the predicted time dependence of this model. With a positive applied field of approximately 3×10^6 V/cm, a surface charge density change of 2×10^{12} cm^{-2} takes place between 10 sec and 1000 sec after a bias change. The time dependence matches that predicted by the uniform trap distribution. For the devices that have a similar time dependence as the exponential trap distribution model, an approximate charge density shift of 7×10^{11} cm^{-2} takes place during the same time. If the charge density changes for the capacitors of these two groups are measured as a function of temperature activation energies of 0.04 eV and 0.11 eV are found. The primary difference between these two groups was the ratio of SiH_4 and NH_3 during deposition, with the group exhibiting an exponential trap distribution having a higher NH_3 concentration. This charge change was found to be asymmetrical. With a negative bias applied, the same charge shift took place in a much shorter time. Unequal electron and hole barriers between the Si and the SiN was postulated, with the hole barrier being much smaller than the electron barrier. Other data have been incorporated into this thesis, including results from a limited number of gamma radiation experiments, for completeness. (Disser. Abstr.)

6729 ORIENTATION AND HABIT PLANE RELATIONSHIPS FOR CARBIDE AND NITRIDE PRECIPITATES IN MOLYBDENUM. Ryan, N. E.; Soffa, W. A.; Crawford, R. C. (Oxford Univ.). Metallography, 1: 195-200(Nov. 1968).

Precipitation of group IVa carbides and nitrides (TiC, TiN, ZrC, ZrN, HfC, and HfN) in molybdenum has been studied with electron microscopy. The precipitates display a characteristic platelike morphology, and contrast effects suggesting coherent nucleation have been observed. The zirconium and hafnium carbides and nitrides exhibit a cubic {100} habit plane and an orientation relationship with the matrix characterized as follows: $\{100\}_{Mo} // \{100\}_{ppt}$, $\langle 100\rangle_{Mo} // \langle 110\rangle_{ppt}$, and $\langle 110\rangle_{Mo} // \langle 100\rangle_{ppt}$. Platelike precipitates of titanium carbide and titanium nitride, however, exhibit an apparent $\{310\}_{Mo}$ habit plane. An analysis of the mismatch parameters and an approximate calculation of the relative strain energies associated with coherency for various possible habit planes and matrix-precipitate orientation relationships confirm the $\{100\}_{Mo}$ habit for the zirconium and hafnium carbide and nitride precipitates. The theory predicts the observed $\{310\}_{Mo}$ habit plane for the titanium carbide and nitride phases with the following orientation relationship: $\{310\}_{Mo} // \{113\}_{ppt}$, $\langle 113\rangle_{Mo} // \langle 112\rangle_{ppt}$, and $\langle 100\rangle_{Mo} // \langle 110\rangle_{ppt}$. (auth)

6730 EFFECT OF HEATING TEMPERATURE ON FRICTION CHARACTERISTICS OF COMPOSITION ON THE BASE ON W, W_2B_5, AND WC. Dzhafarov, Ya. A.; Rozhenko, A. F. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 10, 80-4(Oct. 1968). (In Russian).

The process of dry friction was investigated for materials such as W, W_2B_5 and WC with additives of boron nitride heated in open air. The profiles are found from the friction factor and wear as function of heating temperature. (tr-auth)

6731 THERMODYNAMIC PROPERTIES OF REFRACTORY TRANSITION METAL COMPOUNDS. Kaufman, Larry; Bernstein, Harold (ManLabs, Inc., Cambridge, Mass.). Contracts AF33(657)-9826; AF33(615)-2352. pp 269-97 of Anisotropy in Single-Crystal Refractory Compounds. Vol. 1. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio. See CONF-670637-(Vol.1).

Thermodynamic information on the borides of Zr, Ti, Ta, Nb, and Hf is reviewed in order to assess the availability of classical free energy and entropy data for stoichiometric compounds. This assessment is expanded to consider the broader problem of the interaction of thermodynamic information with phase equilibria and vaporization of refractory transition metal compounds. Applications of models for defining the behavior of compound phases existing over a range of compositions to compute congruent vaporization and melting conditions are included. Moreover, application of computer techniques for predicting complete phase diagrams and thermodynamic properties of binary systems is discussed. The efficacy of the general approach in predicting ternary phase equilibria and guiding complex experimental investigation of ternary systems, and the application to three component composites are considered. (auth)

6732 PLASTIC PROPERTIES IN TUNGSTEN MONOCARBIDE. Pons, L. (Univ. of Caen, France). pp 393-444 of Anisotropy in Single-Crystal Refractory Compounds. Vol. 2. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio. See CONF-670637-(Vol.2).

WC was submitted to precise micrographic observations during tests for indentation, impact and friction on rocks. These tests were made on large-grain sintered test specimens of recently manufactured industrial WC with or without cobalt. WC showed plasticity at ordinary temperatures as revealed by the appearance of rectilinear slip lines in the vicinity of Vickers indentations or else during mechanical impact tests. By using X rays to determine the orientation of a WC crystal, it was found that the slips occurred along the three prismatic planes $(10\bar{1}0)$. The slip directions were determined as being directions [0001] and $\langle 11\bar{2}0\rangle$ which correspond to the two more-or-less equivalent minimum Burgers vectors. A study was made of the recrystallization and sintering of WC at high temperatures. The morphology of WC crystals was determined. A study was made of some particular aspects of the growth of grains at high temperatures. The brittleness of WC depends on the crystallographic orientations. The hardest planes (0001) offer the most possibilities of plastic deformation and are more easily fractured than prismatic planes. The intragranular fracturation of WC is always accompanied by plastic deformations the extent of which depends on the orientation of the crystals. (J.C.W.)

6733 ON THE ROLE OF DIFFUSION IN THE PLASTIC DEFORMATION OF TRANSITION METAL CARBIDES. Harrod, D. L.; Fleischer, L. R. (Westinghouse Astronuclear Lab., Pittsburgh). pp 341-56 of Anisotropy in Single-Crystal Refractory Compounds. Vol. 1. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio. See CONF-670637-(Vol.1).

The general deformation behavior of carbides is investigated. Diffusion data on transition metal carbides of the Group IVB and Group VB metals including TiC, ZrC, HfC, VC, NbC, and TaC are summarized. (J.C.W.)

6734 THERMODYNAMIC PROPERTIES OF HOMOGENEOUS NIOBIUM CARBIDE AT 1200 TO 2500°K. Fesenko, V. V.; Turchanin, A. G.; Guseva, E. A. Zh. Fiz. Khim., 42: 2332-4(Sept. 1968). (In Russian).

On the basis of previously accomplished work, the enthalpy, heat capacity, and change of entropy of homogeneous niobium carbide of four compositions were tabulated in the range from 1200 to 2500°K. By using experimental and literature data, absolute entropies were calculated and thermodynamic potentials given for the same temperature range. (tr-auth)

6735 APPLICATION OF THE ELECTRON MICROPROBE TO THE STUDY OF REFRACTORY METAL CARBIDES, OXIDES, AND SILICIDES. Moll, Sheldon H.; Bruno, George W. (Advanced Metals Research Corp., Burlington, Mass.). Contracts AF33(657)-10390; AF33(615)-3786. pp 23-36 of Anisotropy in Single-Crystal Refractory Compounds. Vol. 1. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio. See CONF-670637-(Vol.1).

The compositional homogeneity, impurity distribution and stoichiometric range have been examined in both as-grown and thermally treated single crystals of refractory metal carbides, oxides, and silicides. The necessary equipment and techniques for the point by point analysis include the study of second phases in as-grown Mo_2C and WSi_2 single crystals and the analysis of decomposition and impurity reaction products in heat-treated crystals. Stoichiometric variations were also determined in TiC crystals by direct analysis of the local carbon content. (J.C.W.)

6736 THE THERMAL CONDUCTIVITY OF THORIA POWDER FROM 400 TO 1200°C IN VARIOUS GASES AT ATMOSPHERIC PRESSURE. Feith, A. D. (General Electric Co., Cincinnati). pp 703-9 of Thermal Conductivity. Flynn, Daniel R.; Peavy, Bradley A. Jr. (eds.). Washington, D. C., National Bureau of Standards, 1968.

From 7th Conference on Thermal Conductivity, Gaithersburg, Md. See NBS-SPEC.PUBL.-302; CONF-671110.

The thermal conductivity of powdered thoria at 75% of theoretical density was measured in a radial heat flow apparatus. Several different types of gas (He, N_2, He + 52% N_2, Ar) were introduced into the powder matrix to study the effect of the conductivity of the gas phase on the conductivity of the compact. The results of this work indicate that the thermal conductivity of the system varies only slightly, if at all, from one gas to another, but considerably lower conductivity values are obtained when the pore phase is evacuated. With a gas present, values of about 1.25 $Wm^{-1} deg^{-1}$ at 400°C, 1.05 $Wm^{-1} deg^{-1}$ at 1000°C, and 1.5 $Wm^{-1} deg^{-1}$ at 1200°C were obtained whereas in vacuum the values were about 0.5 $Wm^{-1} deg^{-1}$ in the 400 to 750°C temperature range. The estimated precision of the data including the effect of the different gases was about ±10%. (auth)

6737 THERMAL CONDUCTIVITY OF URANIUM OXYCARBIDES. Bates, J. Lambert (Battelle Memorial Inst., Richland, Wash.). pp 477-89 of Thermal Conductivity. Flynn, Daniel R.; Peavy, Bradley A. Jr. (eds.). Washington, D. C., National Bureau of Standards, 1968.

From 7th Conference on Thermal Conductivity, Gaithersburg, Md. See NBS-SPEC.PUBL.-302; CONF-671110.

The thermal diffusivity of uranium oxycarbide was measured from 100 to 1500°C as a function of oxygen concentration from 2 to 17 at. % of the anions. The thermal diffusivity (a) of the oxycarbides decreased and the shape of the a-versus-T curve changed as the oxygen content increased. Oxycarbides with the lowest oxygen content showed a decrease in a as the temperature increased, whereas the oxycarbides with the highest oxygen content exhibited a slight increase in a with an increase in temperature. The thermal diffusivities of all specimens approach a common value near 5×10^{-6} m^2/s at the higher temperatures. The calculated thermal conductivities near 1500°C of the uranium oxycarbides are approximately 18 W $m^{-1} deg^{-1}$, very near the reported values for nearly stoichiometric and slightly hypostoichiometric UC. The thermal conductivities of the oxycarbides can be qualitatively separated into an electronic component, obeying the Wiedemann–Franz–Lorentz law, and a lattice component, varying inversely with temperature. The decrease in thermal conductivity at the lower temperatures with increasing oxygen content results primarily from changes in the lattice component. Small decreases also occur in the electronic component over the entire temperature range due to increases in oxygen content. (auth)

6738 SUITABILITY OF THE FLASH METHOD FOR MEASUREMENTS OF THE THERMAL DIFFUSIVITY OF URANIUM DIOXIDE SPECIMENS CONTAINING CRACKS. Shaw, D.; Goldsmith, L. A.; Little, A. J. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). pp 469-76 of Thermal Conductivity. Flynn, Daniel R.; Peavy, Bradley A. Jr. (eds.). Washington, D. C., National Bureau of Standards, 1968.

From 7th Conference on Thermal Conductivity, Gaithersburg, Md. See NBS-SPEC.PUBL.-302; CONF-671110.

The accuracy of thermal diffusivity measurements by the flash-method on reactor fuel specimens containing cracks is discussed. A theoretical treatment for a specimen containing a "model" crack showed that the thermal diffusivity as measured by the flash-method will probably be within 5% of the value derived from a steady-state heat flow method. Measurements on Armco Iron specimens containing restricted heat-flow paths confirmed this conclusion. (auth)

6739 THERMAL DIFFUSIVITY OF ACTINIDE COMPOUNDS. Moser, J. B.; Kruger, O. L. (Argonne National Lab., Ill.). pp 461-6 of Thermal Conductivity. Flynn, Daniel R.; Peavy, Bradley A. Jr. (eds.). Washington, D. C., National Bureau of Standards, 1968.

From 7th Conference on Thermal Conductivity, Gaithersburg, Md. See NBS-SPEC.PUBL.-302; CONF-671110.

The thermal diffusivity of the carbides of uranium and plutonium was measured from 500 to 1500°C by means of the USNRDL flash technique. A ruby laser was used as the pulsing source while the disk-shaped specimens were heated in a high vacuum resistance furnace. The rear surface temperature of the specimen was monitored by an optical detector which contained a dual lead sulfide photoconductor in a temperature compensating circuit. The variations in thermal diffusivity as a function of effective carbon content and uranium-plutonium ratio are discussed and compared with results of other investigations. (auth)

6740 HIGH-TEMPERATURE RADIAL HEAT FLOW MEASUREMENTS. Brazel, J. P. (General Electric Co., Philadelphia); Styhr, K. H. pp 415-24 of Thermal Conductivity. Flynn, Daniel R.; Peavy, Bradley A. Jr. (eds.). Washington, D. C., National Bureau of Standards, 1968.

From 7th Conference on Thermal Conductivity, Gaithersburg, Md. See NBS-SPEC.PUBL.-302; CONF-671110.

Steady state thermal conductivity measurements on three molded graphite structures and one phenolic Refrasil Char composite are presented. Electrical resistivity data and structural characterization of the specimens are included for correlation with other literature values. Measurements were made in flowing argon at mean specimen temperatures in the range 125 to 2000°C. Thermal conductivity (λ) of ATJ grade graphite can be reduced almost 50% at 1000°C from about 6 to 3 mW/m°C by a process of leaching and outgassing. Reduction in λ is less at higher temperatures, about 30% at 1800°C from 2.6 to 1.8 mW/m°C. Specimen hot face temperatures exceeding 2200°C in most cases could not be reached due to the high thermal conductivity of selected specimens and a power supply limitation. A modified apparatus with a larger power supply and equipped for high vacuum as well as inert atmosphere operation is described. (auth)

6741 THERMAL PROPERTIES OF SNAP FUELS. Weeks, C. C.; Nakata, M. M.; Smith, C. A. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. pp 387-98 of Thermal Conductivity. Flynn, Daniel R.; Peavy, Bradley A. Jr. (eds.). Washington, D. C., National Bureau of Standards, 1968.

From 7th Conference on Thermal Conductivity, Gaithersburg, Md. See NBS-SPEC.PUBL.-302; CONF-671110.

The thermal conductivity of uranium-fueled zirconium hydride was obtained from thermal diffusivity, density, and specific heat over the composition range of H/Zr-1.58 to 1.81 (atomic ratio). The thermal properties measurements of SNAP fuel materials were complicated by the fact that the hydride decomposes at elevated temperatures and also undergoes phase changes in the temperature range of interest. Uncertainties in the phase diagram of the zirconium hydride system also contributed to the difficulties. Diffusivity was measured by the pulsed laser technique. Enthalpy and specific heat were determined with a high pressure hydrogen drop calorimeter. The calorimeter employs a variable temperature receiver to permit measurements to temperatures above and below the numerous phase boundaries in the Zr-U-H system. The data on the various properties measured were analyzed and plotted with the aid of a computer program and are presented as functions of temperature and composition. (auth)

6742 DEVELOPMENT OF HIGH TEMPERATURE THERMAL CONDUCTIVITY STANDARDS. Wechsler, Alfred E. (Arthur D. Little, Inc., Cambridge, Mass.); Minges, Merrill L. pp 77-87 of Thermal Conductivity. Flynn, Daniel R.; Peavy, Bradley A. Jr. (eds.). Washington, D. C., National Bureau of Standards, 1968.

From 7th Conference on Thermal Conductivity, Gaithersburg, Md. See NBS-SPEC.PUBL.-302; CONF-671110.

The program described encompasses an analytical and experimental study to establish high-temperature thermal conductivity and thermal diffusivity standards and to test these standards at several property measurement laboratories. Candidate ceramics, intermetallics, metals, and graphites were selected and used in a preliminary laboratory evaluation consisting of heating tests, visual and microscopic examination, and room-temperature thermal conductivity and electrical resistivity measurements. On the basis of test results, alumina, thoria, tungsten, and RVD and AXM-5Q1 graphites were chosen for the laboratory measurement program. Specifications written for these materials and the results of receiving inspection and density measurements of the samples obtained are presented. The status of measurements at participating laboratories is briefly described. (auth)

6743 THE STATE OF KNOWLEDGE REGARDING THE THERMAL CONDUCTIVITY OF THE NON-METALLIC ELEMENTS: THOSE SOLID AT NORMAL TEMPERATURE. Ho, C. Y.; Powell, R. W. (Purdue Univ., West Lafayette, Ind.). pp 33-46 of Thermal Conductivity. Flynn, Daniel R.; Peavy, Bradley A. Jr. (eds.). Washington, D. C.; National Bureau of Standards, 1968.

From 7th Conference on Thermal Conductivity, Gaithersburg, Md. See NBS-SPEC.PUBL.-302; CONF-671110.

Of the 103 chemical elements, experimental thermal conductivity data are available for 62 metallic elements, 9 non-metallic solids and 11 non-metallic fluids. The available thermal conductivity data for the 9 non-metallic solid elements are reviewed. These are arsenic, boron, carbon (in the forms of diamond and graphite), iodine, phosphorus, selenium, silicon, sulfur, and tellurium. (auth)

6744 HEAT CAPACITY AND THERMODYNAMIC PROPERTIES OF PLUTONIUM DIOXIDE. Kruger, Owen L. (Argonne National Lab., Ill.); Savage, Howard. J. Chem. Phys., 49: 4540-4(Nov. 15, 1968).

Changes in the heat content of PuO_2 were measured from 192 to 1400°K with an isothermal drop calorimeter. The enthalpy curve, which was a smooth function of temperature, is described by the equation $H_T - H_{298} = -8468 + 22.18T + 1.040 \times 10^{-4}T^2 + 4.935 \times 10^5T^{-1}$. The first derivative of this equation gave the heat-capacity relation, $C_p = 22.18 + 2.080 \times 10^{-4}T - 4.935 \times 10^5T^{-2}$. At 298°K this equation agrees with previously reported low-temperature measurements made with an adiabatic calorimeter. These high- and low-temperature data were combined to obtain standard-state heat content, heat capacity, entropy, and Gibbs free energy functions to 1800°K. Measurements made previously show that PuO_2 has a temperature-independent magnetic susceptibility below 1000°K. This behavior explains the comparatively low entropy of 16.34 cal mole^{-1} · deg^{-1} for stoichiometric PuO_2 at 298°K, which is somewhat greater than the value found for ThO_2 and considerably less than the values for UO_2 and NpO_2. (auth)

Structure and Phase Studies

Refer also to abstracts 6701 and 6717.

6745 CRYSTAL STRUCTURE OF Ti_2ZrO SUBOXIDE. Fykin, L. E.; Glazova, V. V.; Kornilov, I. I.; Ozerov, R. P.; Smirnov, V. P.; Solov'ev, S. P. (Inst. of Physics, Moscow. Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk SSSR, 182: 576-9(Sept. 21, 1968). (In Russian).

Neutron and x-ray studies of the crystalline phase Ti_2ZrO uncovered during investigation of suboxide phases in the Ti-Zr-O systems showed that Ti_2ZrO has a similar structure to the Mn_2TaO_3 found previously in the Mn-Ta-O system. However, in contrast to the Mn_2TaO_3 and δ-TiO_x, the Ti_2ZrO formed inside of the ternary diagram of the Ti-Zr-O with much lower concentration of oxygen than in Mn_2-Ta-O and in δ phase of the Ti-O. Interatomic distances and coordination in the Ti_2ZrO is tabulated. (R.V.J.)

6746 QUATERNARY SYSTEM U-C-O-N AT 1700°C: PHASE RELATIONS IN THE LOW-NITROGEN REGION. Henry, Jack L.; Blickensderfer, Robert; Thompson, Gerald G. (Albany Metallurgy Research Center, Oreg.). J. Amer. Ceram. Soc., 51: 617-21 (Nov. 21, 1968).

Phase relations in the system U-C-O-N at 1700°C were established at nitrogen levels up to an atomic ratio N:C 1:3 by microstructural and x-ray analyses of sintered powder compacts. The extent of the solid-solution field of uranium oxycarbonitride was established on the ternary plane U-$C_{0.75}N_{0.25}$-O. The maximum solubility of oxygen in the solid solution is 14 at. %, corresponding to a composition $U_{0.50}C_{0.27}O_{0.14}N_{0.09}$, compared to 17 at. % on the U-C-O plane. Nine other phase fields were established on the U-$C_{0.75}N_{0.25}$-O plane, all of which contain a uranium oxycarbonitride solid-solution phase and a gaseous phase of CO and N_2. Equilibrium pressure varies from about 0.01 torr in the phase fields containing free uranium to about 200 torr in the field containing solid solution + "UC_2" (oxygen-containing dicarbide) + C + UO_2. Lattice parameters of the solid-solution phase were determined. A field containing solid solution and U_2C_3 exists to about 3.5 at. % O and 2 at. % N at the hyperstoichiometric boundary of the solid-solution field. An isothermal phase diagram for the low-nitrogen region of the U-C-O-N system is proposed. (auth)

6747 METHODS OF SPECIMEN PREPARATION FOR ELECTRON-MICROGRAPHS OF HARD METALS. Peter, Walter; Kohlhaas, Erich; Fischer, Alfred (Versuchsanstalt der Roechling'schen Eisen- und Stahlwerke GmbH, Voelklingen, Ger.). Prakt. Metallog., 5: 115-23(Mar, 1968). (In German and English).

Methods of preparation of electron microscopic replicas are given which permit interpretation of micro-structural details of very fine grained hard metals. Some examples show the image quality which can be attained. Electron micrographs of replicas were compared with scanning electron micrographs. It was found

that the images of the scanning electron microscope were not sufficient to distinguish clearly the various phases in very fine grained hard metal micro-structures. (auth)

6748 ELECTRON MICROSCOPE OBSERVATIONS OF TUNGSTEN SELENIDE. A NESEM SUMMARY. Richman, Marc H. (Brown Univ., Providence). Metallography, 1: 227-32(Nov. 1968).

Dislocations and occlusions in single crystal tungsten selenide grown by chemical transport were studied by electron microscopy to relate dislocation arrangements and electrical and optical properties. Most dislocations were introduced during specimen preparation and are unbranched. In some regions dislocation nodes are found where each partial dislocation behaves independently excluding any optical doubling. Growth occlusions or spherulitic particles are nucleated preferentially at dislocation intersections; their growth was found to alter the arrangement of the dislocations in their vicinity. (F.S.)

6949 BONDING, STRUCTURE, AND MECHANICAL BEHAVIOR OF VC SINGLE CRYSTALS. Lye, R. G.; Hollox, G. E.; Venables, J. D. (Martin Marietta Corp., Baltimore). pp 445-57 of Anisotropy in Single-Crystal Refractory Compounds. Vol. 2. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio. See CONF-670637-(Vol.2).

An approximate band structure for VC has been derived. It is concluded that the bonding in VC arises primarily from interactions between orbitals on the metal atoms, and that this component of the bonding is stronger in VC than in TiC. Measurements of the compressive yield strength of $VC_{0.85}$ single crystals over the range 900 to 1800°C support this conclusion. A domain structure associated with ordered carbon vacancies has been observed in these crystals. The anisotropy introduced by such ordering may also contribute to the higher strength of this material. (auth)

6750 ELECTRON MICROSCOPY OF HIGH-TEMPERATURE MATERIALS. Delavignette, P.; Amelinckx, S. (SCK-CEN, Mol, Belg.). pp 3-26 of Anisotropy in Single-Crystal Refractory Compounds. Vol. 2. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio. See CONF-670637-(Vol.2).

Defects in graphite are studied. The image of dislocation ribbons and the reactions between the ribbons are discussed. Using the electron microscope for photographs at various temperatures, the stacking fault energy of graphite is studied. Different types of defects occurring in nickel oxide, barium titanate, cobaltous oxide, niobium suboxide, tealite, uranium oxide U_4O_9, and tantalum oxide are photographed by the electron microscope. (J.C.W.)

6751 SINGLE CRYSTAL ELASTIC ANISOTROPY AND THE MECHANICAL BEHAVIOR OF POLYCRYSTALLINE BRITTLE REFRACTORY MATERIALS. Hasselman, D. P. H. (Stanford Research Inst., Menlo Park, Calif.). pp 247-65 of Anisotropy in Single-Crystal Refractory Compounds. Vol. 2. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio. See CONF-670637-(Vol.2).

The effect of the anisotropic elastic behavior of individual grains on the mechanical properties of brittle polycrystalline materials is discussed. Semiquantitative estimates are obtained for the micromechanical stress concentrations resulting from the elastic anisotropy of the grains as a function of the degree of elastic anisotropy, grain orientation, and grain shape. Results obtained are discussed in terms of their effect on the macroscopic strength and deformation behavior of polycrystalline aggregates. It is concluded that the elastic anisotropy of the grains constitutes a microstructural variable which can materially affect mechanical behavior of polycrystalline materials. (auth)

6752 STRENGTH OF NONSTOICHIOMETRIC OXIDES. Nadeau, John S. (General Electric Co., Schenectady, N. Y.). pp 361-90 of Anisotropy in Single-Crystal Refractory Compounds. Vol. 2. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio. See CONF-670637-(Vol.2).

Nonstoichiometry produces various kinds of disorder in crystalline ceramics which influence the strength. At low temperatures nonstoichiometry causes hardening apparently due to inhibition of dislocation motion by the defect structure, whereas at high temperatures the nonstoichiometry causes softening. Since at high temperatures a ceramic can become nonstoichiometric by chemical equilibration with the surrounding atmosphere, its performance in structural applications may quickly be compromised. Where high plasticity is desired the influence of nonstoichiometry may be beneficial. The reduction of high temperature strength by nonstoichiometry in $Fe_{1-x}O$, TiO_{2-x}, and UO_{2+x} has indicated that the softening is probably related to the enhancement of diffusion. The nature of the high temperature deformation process is not understood. The available information on defect structures, diffusion, and high temperature strength of the three oxides are reviewed and are compared with a variety of theoretical models to determine whether the softening by nonstoichiometry has a common physical origin. It is concluded that none of the data are as yet sufficiently complete to permit a clear understanding of the phenomenon. (auth)

6753 INFLUENCE OF OCTAHEDRAL SUBCELLS ON THE ELECTRICAL PROPERTIES AND BONDING CHARACTERISTICS OF MOLYBDENUM CARBIDES. Toth, L. E. (Univ. of Minnesota, Minneapolis); Zbasnik, J.; Sato, Y.; Gardner, W. pp 249-66 of Anisotropy in Single-Crystal Refractory Compounds. Vol. 1. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio. See CONF-670637-(Vol.1).

Nowotny and coworkers have demonstrated the importance of the octahedral subcell in the crystal structures of several hundred carbides and nitrides with complex crystal structures and compositions. Molybdenum is unique in that it forms more carbides than any other transition metal and that all these carbides have a common subcell. The heat capacities of αMoC_{1-x}, ηMoC_{1-x}, Mo_2C, and Mo_2BC were measured in the range 1-20°K, as well as the superconducting transition temperatures and superconducting critical fields of these phases and other molybdenum carbides. These measurements demonstrate the importance of the subcell in determining the electrical properties and they also clearly indicate the importance of the molybdenum–carbon interaction in the bonding of the molybdenum carbides. (auth)

6754 PHASE RELATIONSHIPS AND DEFECT STRUCTURE IN DIMOLYBDENUM CARBIDE. Vahldiek, F. W.; Mersol, S. A. (Air Force Materials Lab., Wright-Patterson Air Force Base, Ohio). pp 199-248 of Anisotropy in Single-Crystal Refractory Compounds. Vol. 1. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio. See CONF-670637-(Vol.1).

Phase relationships and stoichiometry variations relative to hexagonal Mo_2C were determined and correlated with the dislocation etch pits and spiral growth epitaxy found on the Mo_2C single crystals studied, using a combination of chemical, x-ray, emission spectrographic, electron diffraction, extraction, electron transmission, and electron microprobe analyses. A veining substructure, superposed by a discontinuous lamellar slip substructure, was observed on all planes of the Mo_2C crystals and determined to be off-stoichiometric $Mo_2C_{0.97}$. A substructure transition from veins to polygon walls to bands, associated with the formation of γ'-MoC and Mo, with a concomitant increase in dislocation density from 5×10^8 to 1×10^9 dislocations/cm^2, was observed after annealing in vacuum at 1800, 2000, and 2150°C, respectively. The γ'-MoC formed was found to correspond to the formula $MoC_{0.81}$. After annealing at 2200°C or above, band formation only occurred, with the bands being primarily Mo. The phase relationships found were confirmed by microhardness measurements. The slip and twin tracers produced by room-temperature microhardness indentations of the Mo_2C single crystals were studied. Anisotropy in electrical resistivity and elastic modulus was found and correlated with microhardness anisotropy and Mo_2C crystal structure. A covalent and a metallic bonding mechanism is postulated for the Mo-C system. (J.C.W.)

6755 BONDING, IMPERFECT STRUCTURE, AND PROPERTIES OF THE REFRACTORY NITRIDES OF TITANIUM, ZIRCONIUM, AND HAFNIUM. Straumanis, M. E. (Univ. of Missouri, Rolla). pp 121-38 of Anisotropy in Single-Crystal Refractory Compounds. Vol. 1. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio. See CONF-670637-(Vol.1).

Titanium, zirconium, and hafnium nitrides were investigated by chemical means by x-ray diffraction concerning their structure. From the dissolution of the nitrides in HF (under formation of NH_4^+, N_2, and H_2), from N_2 production at elevated temperatures in vacuum and furthermore, from the heats of formation, lattice energies, hardness, and high melting points, the conclusion was drawn that the bonding in the three nitrides is of a mixed type. The bonding appears to be predominantly ionic and to some extent metallic; the cationic sublattice consists throughout of the

trivalent ions (Ti^{3+}, Zr^{3+}, and Hf^{3+}) and there is a nitrogen equilibrium ($N^{-3} \rightleftharpoons N + 3e$) in the anionic sublattice. The partially metallic character of the bonding accounts for the high electrical conductivity, magnetic properties, and metallic luster of the nitrides. Since the N atoms do not accept all the available valence electrons from the metal atoms, the average radius of the N anions must be smaller, from 1.4 to 1.425 Å, (depending upon the degree of ionization of N) than that calculated for N^{-3}. Using these values for the N ionic radius and the radii of the three trivalent cations, a good agreement between calculated and experimental lattice constants can be reached. There are vacant sides (cationic and anionic) in the three nitrides: 5.14 in the TiN, 4.59 in the ZrN (both containing an excess of N), and 12.62% in the stoichiometric HfN. (auth)

6756 CRYSTALLOGRAPHIC POLARITY OF WC. French, D. N.; Thomas, D. A. (Ingersoll-Rand Research Center, Princeton, N. J.). pp 55-66 of Anisotropy in Single-Crystal Refractory Compounds. Vol. 1. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio. See CONF-670637-(Vol.1).

The hexagonal crystal structure of WC is non-centrosymmetric, resulting in polar character of crystal faces of the $\{10\bar{1}0\}$ type. One consequence of this is the formation of triangular-prism crystals bounded by $\{10\bar{1}0\}$ faces. A number of simple experimental methods have been investigated for revealing the polar behavior of WC, similar to the extensive studies by others on A_{III}-B_V and A_{II}-B_{VI} compounds. The experiments include K_2CO_3 electrolytic etching, contact angles of liquid drops, and microhardness. These results are discussed in terms of the crystal structure and bonding of WC. (auth)

6757 SOME ASPECTS OF THE CRYSTAL CHEMISTRY OF BORIDES, BORO-CARBIDES, AND SILICIDES OF THE TRANSITION METALS. Aronsson, Bertil (Swedish Inst. for Metal Research, Stockholm); Lundstroem, Torsten; Engstroem, Ingvar. pp 3-22 of Anisotropy in Single-Crystal Refractory Compounds. Vol. 1. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio. See CONF-670637-(Vol.1).

New results on Me_2B borides with the $CuAl_2$ structure and on boro-carbides with the $Cr_{23}C_6$ structure are presented. The results are discussed with particular emphasis on the occurrence of B-C substitution. Detailed structural data on NbB_2, CrB_4, MoB_4, WB_2, and Ru_2B_3 are reported. Some general comments are given on the crystal chemistry and stoichiometry of borides with compositions in the range MeB-MeB_4. Their relationship to the refractory carbides is particularly considered. The crystal structures of Rh_4Si_5 and Rh_3Si_4 are presented. They are closely related to the MnP structure. (auth)

6758 PHASE STUDIES IN THE SYSTEM: $YNbTiO_6$–$NdNbTiO_6$. Deshpande, V. V.; Rao, K. Rama (Coll. of Science, Nagpur, India). Curr. Sci. (India), 37: 68-9(Dec. 5, 1968).

Solid-state reactions were used to study phases in the $YNbTiO_6$–$NdNbTiO_6$ system. Only limited solid solution occurs in the system. A new orthorhombic phase of $NdNbTiO_6$ was observed in the system. (M.C.G.)

6759 STABILIZATION OF THE PHASE TRANSFORMATIONS IN HAFNIUM OXIDE. Buckley, John Dennis. Ames, Iowa, Iowa State Iniv., 1968. 110p.

Thesis.

The need for thermal shock-resistant refractories, used as structures or as a protective coating on aerospace vehicles, initiated an investigation of HfO_2–CaO, HfO_2–Y_2O_3, and HfO_2–MgO solid solutions. This study included: (1) an investigation of the effect of time and temperature on the solubility of oxide additions (CaO, Y_2O_3, and MgO) to hafnia, (2) an analysis of composition changes resulting from sintering at several temperatures for varying times, (3) a determination of the lattice parameters of cubic-phase hafnia characteristic of each of the solid solutions, (4) an examination of phase transformations and the solid solubility of the oxide stabilizer additions by high temperature x-ray diffraction, (5) a correlation of metallographic and x-ray analyses to allow visual identification of phase- and grain-boundary composition, (6) a determination of the effect of cyclic heating on the stability of solid solutions, and (7) an observation of the effects of thermal shock on partially and fully stabilized hafnia. (TSS)(Disser. Abstr.)

6760 TERNARY PHASES WITH THE STRUCTURE OF THE U_3Si_2 TYPE IN THE W–Mn–B AND Mo–Mn–B SYSTEMS. Telegus, V. S.; Kuz'ma, Yu. B. (Lvov State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 10, 951-3(1968). (In Ukrainian).

The existence of the ternary phases $(W,Mn)_3B_2$ and $(Mo,Mn)_3B_2$ with the tetragonal structure of the U_3Si_2 type was established by means of x-ray powder diffraction. The former compound has a completely ordered arrangement of the atoms of all the components at the composition W_2MnB_2. Within the range of homogeneity the lattice constants are: $(W,Mn)_3B_2$: a = (5.748 ÷ 5.786) ± 0.005 Å, c = (3.151 ÷ 3.160) ± 0.003 Å, c/a = 0.548 ÷ 0.546; $(Mo,Mn)_3B_2$: a = (5.781 ÷ 5.812) ± 0.005 Å, c = (3.127 ÷ 3.136) ± 0.003 Å, c/a = 0.541 ÷ 0.540. The phase $(W,Mn)_3B_2$ is the ternary compound and the phase $(Mo,Mn)_3B_2$, probably, is a solid solution on the Mo_3B_2 base stabilized at 900°C by manganese. (auth)

Radiation Effects

Refer also to abstract 6715.

6761 (GA–7551) DESCRIPTION AND RESULTS OF THE P12 COATED PARTICLE IRRADIATION EXPERIMENT. Luby, C. S.; Chin, J.; Spillane, B. B. (Gulf General Atomic, Inc., San Diego, Calif.). Dec. 1, 1966. Contract AT(04-3)-167. 58p. Dep. CFSTI.

Twelve types of Buffer-Isotropic (BISO) coated fissile and fertile fuel particles were irradiated in Capsule P12 to burnups of 7% and 2% FIMA (fissions per initial heavy metal atom) for the two types of particles, respectively, at fuel temperatures of 1150 to 1440°C (average = 1360°C). The fast-neutron flux exposure was 1.1×10^{21} nvt (E > 0.18 MeV). This was the first high fast-neutron flux test of coated particles. The results of postirradiation examination indicated that BISO-coated fissile and fertile particles require ratios of coating thickness to fuel particle diameter of at least 0.5 and 0.37, respectively, for survival under these irradiation conditions. In addition, low-density coatings were found to have very high failure rates, and graded coatings were found to have a higher failure rate than monolithic coatings. (auth)

6762 (GA–8888) STRUCTURE AND PROPERTIES OF PYROLYTIC CARBON. Bokros, J. C. (Gulf General Atomic, Inc., San Diego, Calif.). Sept. 6, 1968. Contract AT(04-3)-167. 36p. Dep. CFSTI.

The dependence of both the thermal expansion of pyrolytic carbon and the neutron irradiation-induced dimensional changes on the structure of pyrolytic carbon is discussed. Possible explanations for these dependences are explored. New applications of high-strength carbons deposited in fluidized beds are reported including a prosthetic cardiac valve. (D.H.M.)

6763 IRRADIATION EFFECTS IN SOME CRYSTALLINE CERAMICS. Cummings, W. V. (General Electric Co., Pleasanton, Calif.). Advan. X-Ray Anal., 11: 418-33(1968).

From 16th Annual Conference on Applications of X-Ray Analysis, Denver, Colo. See CONF-670813.

Irradiation effects that were observed in the structures of a number of ceramic materials are reviewed. Results of x-ray diffraction studies indicate that, to a great extent, the magnitudes of the crystallographic changes depend upon the type of crystal structure. However, the nature of the atomic bonding and the type of radiation can be the predominant factor in radiation stability in some materials. Damage mechanisms that were investigated include: fast-neutron and high-energy gamma-ray effects, transmutation effects in high-neutron cross section materials, and the effects of the (n,α) reaction in various boride-containing structures. Some crystallographic changes observed include lattice parameter changes and structure damage of various magnitudes, the appearance of a transmutation product structure, and changes from the crystalline to the amorphous state. (auth)

6764 RADIATION-DAMAGE STRESSES IN THE GRAPHITE OF POWER-PRODUCING NUCLEAR REACTORS. Head, J. L.; Sockalingam, K. C. (Imperial Coll. of Science and Tech., London). J. Mech. Eng. Sci., 10: 402-11(Dec. 1968).

When graphite is irradiated by fast neutrons damage to the crystal structure causes changes of the graphite dimensions. In the graphite blocks comprising the core of a nuclear reactor differential dimensional changes result, and stresses are developed, analogous to thermal stresses in a body in which there are spatial variations of temperature. The stresses are partially relaxed by an irradiation-induced creep of the graphite. A method of predicting the stresses, which makes allowance for the relaxation by irradiation creep, is described. (auth)(UK)

Plastics and Other Materials

6765 FIXATION OF PHOTOELASTIC FRINGE PATTERNS BY GAMMA RAYS. EFFECTS OF CURING REAGENT AND RA-

DIATION DOSE ON OPTICAL AND MECHANICAL PROPERTIES OF EPOXY RESIN. Miyazono, Shohachiro (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo) 5: 579-89(Nov. 1968).

The effects of differences in the weight ratio between the epoxy resin and curing reagent, and in the radiation dose on the amount of residual fringe patterns were studied in detail. The specimens contained 12, 16, 20, and 25 (weight) parts of curing reagent for 100 parts of epoxy resin, and the radiation dose was varied in steps of 0.53×10^8, 1.16×10^8, 1.92×10^8, and 3.17×10^8R on the average. The optical and mechanical properties of epoxy resin were also compared between non-irradiated and irradiated specimens for: photoelastic sensitivity, modulus of elasticity, Poisson's ratio, and Rockwell's hardness. The relationship between the chemical and radiation crosslinking was obtained in an endeavor to throw light on the reason why the amount of residual fringe patterns depended on the epoxy resin/curing reagent weight ratio and on the radiation dose. It was also found that the change and disturbance in the patterns depended on optical creep, time edge-effect, and on the generation of gases by irradiation. (auth)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstract 7309.

6766 PROBABILISTIC MODEL FOR TRANSFER PROBLEM IN AN EXTERNALLY ILLUMINATED SPHERICAL SHELL ATMOSPHERE WITH A PERFECTLY ABSORBING CORE. Leong, T. K.; Sen, K. K. (Univ. of Singapore). Ann. Astrophys., 31: 467-74 (Sept.-Oct. 1968).

A probabilistic model for the scattering function for solving radiative transfer problems in an externally illuminated spherical shell atmosphere with a perfectly absorbing core is proposed. It is shown that this scheme leads to the same type of integro-differential equation for scattering function as that obtained by Bellman, Kagiwada, Kalaba, and Ueno [8] by the imbedding method. (auth)

6767 FORMATION OF EMISSION LINES IN OPTICALLY FINITE GASEOUS ATMOSPHERES. Pecker, Jean-Claude (Observatoire de Nice). Ann. Astrophys., 31: 537-46(Sept.-Oct. 1968). (In French).

The weighting functions, in the case of optically finitely thick atmospheres, are written, and their sign is discussed: the emission is possible, even near LTE conditions. The curves of growth may show a definite minimum, which could be observable in some cases, either in the astrophysical media or in laboratory. (auth)

Cosmic Ray Exposure Ages

6768 ACCRETION RATE OF COSMIC DUST ESTIMATED FROM COSMOGENIC ^{26}Al. Yokoyama, Y. (CNRS, Gif-sur-Yvette, France). Nature (London), 220: 1016-17(Dec. 7, 1968).

A good criterion for recognizing particles of cosmic dust on the Earth is the detection of radionuclides, such as ^{26}Al, formed by the action of cosmic rays on dust in free space. Terrestrial dust is protected by the atmosphere. Results obtained by other authors from ^{26}Al and ^{10}Be are summarized, and estimates made of the upper limit of the accretion rate of cosmic dust bearing ^{26}Al; results are tabulated. It is concluded that the total terrestrial accretion of cosmic dust of 1 to 500 μ does not exceed 1,000 tons/day, and is probably less than 100 tons. (UK)

6769 ORIGIN OF EXCESS HEAVY XENON IN PRIMITIVE CHONDRITES. Rowe, M. W. (Univ. of California, Berkeley). Geochim. Cosmochim. Acta, 32: 1317-26(Dec. 1968).

In heating experiments, xenon was studied in separated matrix and chondrule samples of the Mokoia carbonaceous chondrite and the Chainpur unequilibrated ordinary chondrite. Larger isotopic anomalies in the heavy xenon were found than have previously been seen in carbonaceous chondrites. ^{244}Pu spontaneous fission decay in situ is an unlikely source for the excess heavy xenon. A "carrier" hypothesis is suggested as an alternative source. (auth) (UK)

Stars

Refer also to abstract 6895.

6770 PHOTOELECTRIC OBSERVATIONS OF TWO RR LYRAE STARS, UU VIRGINIS, AND ST CANUM VENATICORUM. Hill, Graham (Univ. of Texas, Austin. Kitt Peak National Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac., 80: 309-13(June 1968).

Photoelectric observations in the UBV system of the two RR Lyrae stars, UU Virginis and ST Canum Venaticorum, are described. (auth)

6771 ELECTRON DENSITIES IN PLANETARY NEBULAE FROM [S II]. Weedman, Daniel W. (Univ. of Texas, Austin). Publ. Astron. Soc. Pac., 80: 314-17(June 1968).

Observations were made of the intensity ratio of the [S II] doublet λ6717, λ6731 in seven planetary nebulae. An expression is given for calculating N_e from the observed ratios, and these N_e are comparable to those found by other methods. It is thus recommended that this ratio be observed in objects where the corresponding [O II] doublet cannot be resolved. (auth)

6772 UBV OBSERVATIONS OF MISCELLANEOUS PECULIAR STARS. Landolt, Arlo U. (Louisiana State Univ., Baton Rouge. Kitt Peak National Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac., 80: 318-22(June 1968).

Photoelectric UBV observations designed to detect long-term brightness and color variations are described for three helium stars: the R Coronae Borealis object, XX Camelopardalis; the peculiar star ρ Cassiopeiae; and the spectroscopic binary KS Persei (HD 30353). (auth)

6773 HYDROGEN LINE PROFILES IN EARLY-TYPE STARS. Brucato, R. J. (Yerkes Observatory, Williams Bay, Wis.). Publ. Astron. Soc. Pac., 80: 263-8(June 1968).

The line profiles of Hβ were photoelectrically measured for α Leo, η UMa, γ Peg, α Del, and δ Cas at a resolution of 0.5 Å. These observed profiles were then compared with profiles predicted by model-atmosphere calculations for rotating and non-rotating early-type stars. (auth)

6774 VARIATION OF THE MICROTURBULENCE PARAMETER WITH CHEMICAL COMPOSITION. Strom, S. E. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Publ. Astron. Soc. Pac., 80: 269-72(June 1968).

It is shown that the correlation found by previous investigators between the value of the microturbulent velocity parameter ξ_t and the iron-to-hydrogen ratio for G dwarfs results from invalid assumptions implicit in the differential curve-of-growth techniques used to derive ξ_t. By using model atmosphere abundance analyses, the deduced values of ξ_t will be very close to the mean value found for stars of approximate solar composition. (auth)

6775 INCIDENCE OF Ap STARS. Wolff, Sidney Carne (Univ. of Hawaii, Honolulu). Publ. Astron. Soc. Pac., 80: 281-9(June 1968).

Counts of the brighter field stars were used to derive the color-index frequency distribution of the Ap stars. It is shown that ~10% of all the main sequence stars in the interval $-0^m19 \leq (B-V) \leq +0^m20$ are peculiar. The ratio of the number of Ap stars to the number of normal stars is a maximum in the interval $-0.09 \leq (B-V) \leq 0.00$ and declines outside this range. The combined color-index frequency distributions of the Ap and Am stars are compatible with the hypothesis that the Ap and Am stars are that fraction of the field stars which have true rotational velocities less than about 90 km/sec. (auth)

6776 SPECTRAL TYPES AND Hγ OBSERVATIONS FOR STARS IN EIGHT ASSOCIATIONS. Walker, G. A. H.; Hodge, S. M. (Dominion Astrophysical Observatory, Victoria, British Columbia). Publ. Astron. Soc. Pac., 80: 290-308(June 1968).

Spectral types and Hγ ($W_{H\gamma}$) equivalent widths were derived from low dispersion (92 Å/mm and 51 Å/mm) spectrograms of the brightest stars in NGC 281, NGC 1893 (Aur OB 2), NGC 6823 (Vul OB 1), NGC 6910 (Cyg OB 9), NGC 6913 (Cyg OB 1), NGC 7380 (Cep OB 1), IC 1805 (Cas OB 6), and the Cyg OB 2 association. The majority of the stars are of O or early-B spectral types. The spectral types are in good agreement with estimates by other observers. The Hγ equivalent widths agree well with photographic measurements from higher dispersion spectra and appear to have a standard error of about 13%. They do not agree satisfactorily with photoelectric Hγ measurements except for values of $W_{H\gamma} < 4.0$ Å. (auth)

6777 USE OF THE BORGMAN LPL α INDEX AS A PHOTOMETRIC METAL INDICATOR. Smith, Myron (Steward Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac., 80: 223-7(Apr. 1968).

The α index, as defined from the LPL eight-color system, is shown to be an effective metallicity indicator for F8 to G4 dwarfs when used with a suitable temperature discriminant defined in the red. Its increased sensitivity over the m_1 index must arise from the 4020 Å filter's higher transmission of the blanketed region shortward of λ4000. If abundance determinations by photometry are to be extended to other types of stars to supplement present curve of growth data, future studies should treat luminosity and effective temperature as separate metallicity calibration problems. (auth)

6778 UBV OBSERVATIONS OF LONG-PERIOD VARIABLE STARS. III. Landolt, Arlo U. (Louisiana State Univ., Baton Rouge. Cerro Tololo Inter-American Observatory, La Serena, Chile). Publ. Astron. Soc. Pac., 80: 228-9(Apr. 1968).

Photoelectric observations of thirteen long-period variable stars are presented in the UBV photometric system. (auth)

6779 CORONAL LINES IN THE SHELL OF T CORONAE BOREALIS. Bochonko, D. R. (Univ. of Michigan, Ann Arbor); Malville, J. McKim. Publ. Astron. Soc. Pac., 80: 177-84(Apr. 1968).

Measurements of the equivalent widths of the coronal lines 5303 Å, 6374 Å, and 5536 Å in the 1946 outburst of T Coronae Borealis are presented. Analysis of the green coronal line leads to an electron density in the coronal envelope of 3 to 5×10^7 cm^{-3} for a radius of 3×10^{14} cm. The euv transitions of Fe XIV in the extreme ultraviolet are estimated to have optical depths of approximately 10^3 at the time of appearance of the coronal lines. (auth)

6780 RECENT LIGHT VARIATIONS OF NOVA GK PERSEI. Mumford, George S. (Tufts Univ., Medford, Mass. Kitt Peak National Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac., 80: 175-6(Apr. 1968).

Early in October, GK Persei was observed photoelectrically with the No. 2, 36-inch Cassegrain reflector at Kitt Peak. Results indicate that V = 12^m.01; (B−V) = +0^m.56; and (U−B) = −0^m.55. (W.D.M.)

6781 BD −8°6189, A NEW W URSAE MAJORIS STAR. Stepien, Kazimierz (Univ. of California, Santa Cruz). Publ. Astron. Soc. Pac., 80: 220-2(Apr. 1968).

In the course of observations of RR Lyrae stars with the 24-inch Lick reflector the star BD −8°6189 was chosen as a comparison star for BS Aquarii. It was not until the observations were reduced in Nov. 1967 that the comparison star itself was found to be variable. The light curve and the behavior of the color indices indicate that the star is of the W Ursa Majoris type with a light range of 0.35 mag. and its expected period should be approximately 12 hours. (W.D.M.)

6782 PHOTOELECTRIC PHOTOMETRY OF THE ECLIPSING BINARY W CORVI. Dycus, Robert D. (San Diego State Coll., Calif.). Publ. Astron. Soc. Pac., 80: 207-16(Apr. 1968).

UBV observations of the eclipsing binary system W Corvi are presented. These observations confirm an uneven shoulder height (greater than one-tenth of a magnitude) indicated by previous visual and photographic observations. Estimated UBV magnitudes are also presented together with a revised ephemeris. A preliminary solution for the light curve was obtained using Kopal's method. The solution for primary eclipse indicated a deep partial transit eclipse. (auth)

6783 SPECTRAL CLASSIFICATIONS OF 239 EARLY-TYPE STARS. Guetter, Harry H. (Naval Observatory, Flagstaff, Ariz.). Publ. Astron. Soc. Pac., 80: 197-206(Apr. 1968).

Spectral types on the Morgan–Keenan system are presented for 239 O- and B-type stars. (auth)

6784 SPECTROGRAPHIC STUDY OF THE ECLIPSING BINARY TX URSAE MAJORIS. Swensen, P. R.; McNamara, D. H. (Brigham Young Univ., Provo, Utah). Publ. Astron. Soc. Pac., 80: 192-6(Apr. 1968).

Orbital elements of the eclipsing binary TX Ursae Majoris were derived from new high-dispersion spectrograms. The elements differ from those obtained previously. Evidence of gas streams is indicated by variable hydrogen absorption cores. (auth)

6785 ROTATIONAL VELOCITIES IN EARLY-TYPE BINARIES. Olson, Edward C. (Univ. of Illinois, Urbana). Publ. Astron. Soc. Pac., 80: 185-91(Apr. 1968).

Measurements of rotational velocities in early-type close binaries reveal small departures from axial–orbital synchronism. These are discussed in terms of angular momentum transfer between the components and evolution away from the main sequence. (auth)

6786 PHOTOELECTRIC OBSERVATIONS OF RAPID MAGNITUDE VARIATIONS IN SS 199 II. Philip, A. G. Davis (State Univ. of New York, Albany. Kitt Peak National Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac., 80: 171-4(Apr. 1968).

Observations are presented of a rapid temporary brightening of 2.4 magnitudes in SS 199 II, a star which has been classified as a possible field horizontal-branch star. (auth)

6787 SPECTRUM VARIATIONS IN THE WOLF–RAYET ECLIPSING BINARY HD 211853. Bracher, Katherine (Univ. of Southern California, Los Angeles. Kitt Peak National Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac., 80: 165-70(Apr. 1968).

The spectrum of HD 211853 shows a variable absorption feature at λ3872. This is interpreted as violet-displaced absorption of He I λ3889, arising either in the W shell or in an envelope around the whole system. The radial velocity of this line varies in phase with the B component; its intensity is strongest when the W star is in front. (auth)

6788 TWENTY-FIVE POLARIMETRIC STANDARD STARS WITHIN TWENTY PARSECS OF THE SUN. Walborn, N. R. (Univ. of Chicago). Publ. Astron. Soc. Pac., 80: 162-4(Apr. 1968).

Twenty-five stars within 20 parsec of the Sun and between 15 and 23 hours of right ascension were observed polarimetrically with the Yerkes 24-inch rotatable telescope. (W.D.M.)

6789 INVESTIGATION INTO THE MODE OF EXCITATION OF THE SYMBIOTIC VARIABLES. Ilovaisky, Sergio A.; Wallerstein, George (Univ. of Washington, Seattle). Publ. Astron. Soc. Pac., 80: 155-61(Apr. 1968).

The nature of the symbiotic stars is discussed from a morphological point of view. A method is described to study the problem of the energy source for the high-excitation emission lines in the spectra of these stars. There appear to be two general types of symbiotics: one in which excitation by dissipation of shock wave is probably responsible for the energy, and the other where radiative excitation similar to that in planetary nebulae and H II regions seems indicated. (auth)

6790 DETERMINATION OF STELLAR PARAMETERS FROM LUNAR OCCULTATION OBSERVATIONS. Kremser, Thurman Rodney. Philadelphia, Temple Univ., 1967. 130p. Thesis.

The technique first used in this study makes use of a photomultiplier tube and an electrometer amplifier whose output signal is then recorded on magnetic tape using a precision laboratory tape recorder operated in an fm mode thereby recording signals in a frequency range from dc to 2500 Hz. Once recorded, the signal may be played back repeatedly, observing and photographing the waveform using an oscilloscope. Simultaneous recording of standard time signals allows a precise determination of the time of the occultation. The determination of the angular diameter of a star is based on the diffraction pattern of a disk source and straight edge in nonmonochromatic light, where there is a dependence on the angular diameter of the source, as indicated by the ratio of the intensity of the first maximum in the diffraction pattern to the free field intensity. The apparent separation of binary stars in the direction of the motion of the advancing limb of the moon, and the relative intensities of the two components are calculated directly from the two superimposed diffraction patterns obtained during the occultation of the binary. Observations of four stars are analyzed, including one binary, 9α Librae, having components with a magnitude difference of 0.34 ± 0.06 in light of 4150 Å wavelength, and having an apparent angular separation of 0″.0113 ± 0″.0017. The lower limit on the period of revolution of the system is calculated to be in the range of 20 to 28 days. A slight anomaly in the diffraction pattern tends to indicate that the brighter component is also a close binary. The other stars, 46 Leonis, 167B Leonis, and 8 Librae were found to be single stars. The angular diameter of 46 Leonis as measured in light of 5125 Å wavelength was found to be 0″.0060 ± 0″.0009, not corrected for limb darkening. No values were obtained for the angular diameters of 167B Leonis and 8 Librae due to the presence of a large amount of atmospheric scintillation noise in the recorded signal. It is estimated, however, that the angular diameters of both of these stars are below the limit of resolution of the method described. (Diss. Abstr.) (TSS)

6791 A SEARCH FOR PERIODIC LIGHT VARIATIONS AMONG THE dMe AND dM TYPE STARS. Krzeminski, W. Postepy Astron., 16: 293-6(1968). (In Polish).

There are about 100 stars emitting lines of H and ionized Ca; some of them exhibit flares characterized by a light increase lasting several tenths of seconds, followed by slow decrease of the light intensity. These flares are often accompanied by changes in the optical spectrum and radio emission. In order to determine whether other stars exhibit similar emissions, the stars in the dK7 to dM3.5 spectral range were examined during 1966/67 by means of the 1.5-m telescope at the Mt. Wilson Observatory. Six of the stars were found to be variable, with a complete decrease of the amplitude with respect to observations made during 1965/66. The stars BD + 34°106 and HDE 234677 were found to be spectroscopic twins; stars AC + 31°70565 did not show any radial change. The pulsation curve method could not be used because the periods were two orders of magnitude higher than the pulsation periods of unstable M-type stars. The presence of Ca^{2+} and H lines and the flare activity does not contradict the possibility of spots on the surface of the dME-type stars. (TTT)

6792 MICROTURBULENCE IN MAIN-SEQUENCE STARS. Chaffee, Frederic Henry Jr. Tucson, Ariz., Univ. of Arizona, 1968. 148p. Thesis.

High-dispersion spectra were obtained for 23 main-sequence

stars in the spectral range from A0 to G0. Spectra were observed in the green for 17 of these stars at a dispersion of 17.8 A/mm, and in the blue for 8 of the stars at a dispersion of 8.9 A/mm. Microturbulent velocities were determined for each of these stars from a curve of growth analysis of approximately 90 Fe I lines in each stellar spectrum. (Diss. Abstr.) (TSS)

6793 ON THE APPLICATION OF TV FOR THE SEARCH OF SUPERNOVAE. Abramenko, A. N.; Prokof'eva, V. V. Izv. Krym. Astrofiz. Observ., 38: 252-6(1967)(Publ. 1968). (In Russian).

The method of TV patrol of supernovae in selected galaxies is proposed. It is possible to see bright supernovae on the TV screen. The modification of readout, which allows seeing a faint source near a bright one, is described. (auth)

6794 INFRARED ASTRONOMY. Brancazio, Peter J.; Cameron, A. G. W. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1968. 256p. $15.00.

The papers presented at this conference cover a number of different fields in infrared astronomy. Topics included were interstellar extinction in the infrared, survey of 2 to 2.5 μ, observations of quasars and cool stars, stellar spectra, spectra of cool stars, infrared intensity distribution at the solar limb in the 20-μ region, model atmospheres for cool stars, infrared rocket observations, measurement of the cosmic microwave background with interstellar molecules, emission line objects, infrared spectrum of interstellar shock waves, protostars, infrared observations of Comet 1965f, dry massive model of the atmosphere of Venus, opacity of the Venus atmosphere, model of the clouds and atmosphere of Venus, interferometric spectra of plants, and models of the Jovian atmosphere. (W.D.M.)

6795 INVESTIGATION OF THE SPECTRUM OF TURBULENCE IN THE APPLICATION FOR STELLAR ATMOSPHERES. Gollandskii, O. P.; Chub, A. T. Izv. Krym. Astrofiz. Observ., 38: 229-44(1967)(Publ. 1968). (In Russian).

The nonlinear differential equation was investigated by numerical methods. To this equation the spectral one of the stationary isotropic turbulence with the energy transfer term in Heisenberg's form, taking into account the energy dissipation of shock waves, was reduced. Numerical solutions with different functions ζ, being a member of the equation, were obtained. It is shown, that for those functions, the derivative of which $\zeta' \ll \zeta$, the spectral function decreases monotonously all over the region of the determination. For those functions ζ, whose ζ' (in a certain interval of values of independent variable) is of the same order of magnitude as ζ itself, the spectral function has a relative minimum. The stationarity of such a kind of spectrum is found to be questionable from physical considerations. There is an investigation of the spectral equation of the stationary isotropic turbulence with the energy transfer term in Obukhov's form, taking into account the energy dissipation of shock waves. It is shown that in the region of small wave numbers the spectrum has a form of $E(k) \sim k^{-\frac{5}{3}}$, in the vicinity of zero $- E(k) \sim k$. (auth)

6796 PHOTOELECTRIC OBSERVATIONS OF FLARE STARS. IV. PHOTOMETRY IN H_δ LINE OF FLARES OF UV CETI. Chugainov, P. F. Izv. Krym. Astrofiz. Observ., 38: 200-4(1967)(Publ. 1968). (In Russian).

The light curves of 11 flares of UV Cet were obtained with interference filters λ4861 and λ4990 Å (half-widths 70 Å). Curves of equivalent width of H_δ with respect to proper continuous radiation of flare were obtained for 5 flares. It was found that immediately after the flare maximum the values of W_{H_δ} begin to increase, reaching the maximal value, and then decrease. Minimal values of W_{H_δ} are within the limits of 15 to 90 Å, maximal ones, 90 to 300 Å. It shows that a part of continuous radiation in the total flare radiation is large enough. In particular it is considerably larger, than in the case when the radiation leaves an optically thin hydrogen cloud. (auth)

6797 ANALYSIS OF SIMULTANEOUS PHOTOMETRIC AND SPECTROGRAPHIC OBSERVATIONS OF AD LEO AND UV CET FLARES. Gershberg, R. E. Izv. Krym. Astrofiz. Observ., 38: 177-99(1967)(Publ. 1968). (In Russian).

Simultaneous photometric and spectrographic observations of AD Leo and UV Cet flares were analyzed quantitatively. The observed equivalent widths of emission hydrogen lines and the ratios of the continuous radiation of flares to the stellar continuum were compared with the corresponding values which were calculated from the brightnesses of flares assuming that the flare radiation is due to a hot recombining gas. There is an agreement between the corresponding values if one supposes that (1) the hot gas has a coronal temperature and a small optical thickness in Balmer lines, or (2) this gas has a chromospheric temperature and a decrease of Balmer lines radiation is due to a self-absorption or due to an absorption of the line radiation in higher layers of stellar atmosphere. The observed widths of emission hydrogen lines give an upper limit of temperature in flares (1 to 30) $\times 10^6$°K or an upper limit of macroscopic velocities 100 to 800 km/sec. The possible processes of a flare formation—a coronal condensation, a solar chromospheric flare-type process, an appearance of a shock front above the photosphere—are discussed briefly. The coronal condensation is the least possible mechanism because a mass of the recombining gas in strong flares is too large to be a part of the stationary stellar corona. The absence of chromospheric and photospheric models for dM5 stars hampers the theoretical considerations of other processes. (auth)

6798 COLORS OF SYMBIOTIC STARS. Belyakina, T. S. Izv. Krym. Astrofiz. Observ., 38: 171-6(1967)(Publ. 1968). (In Russian).

Photoelectric colors of symbiotic stars AX Per, AG Dra, YY Her, V443 Her, CI Cyg, AG Peg, and Z And were obtained with the new 70-cm reflector of the Crimean observatory. These stars locate on two-color diagram considerably to the right of the main sequence. The observed colors of Z And are represented well by colors, calculated by the combined radiation of three components: M2 III + a hot star + recombining hydrogen emission ($T_e = 17{,}000°$, $n_e = 10^7$). It conforms well to spectroscopic observations. (auth)

6799 SPECTROPHOTOMETRIC INVESTIGATION OF Z AND IN 1960–1965. Boyarchuk, A. A. Izv. Krym. Astrofiz. Observ., 38: 155-70(1967)(Publ. 1968). (In Russian).

The identification was carried out and relative intensities ($I_{H_\delta} = 100$) of emission lines are given. The energy distribution in the continuous spectrum was found. It is shown that relative intensities of H, He I, and He II emission lines have an anomalous distribution which can be explained by the influence of the large optical thickness and of medium heterogeneities. The supposition is confirmed that Z And is a binary star, consisting of the cold component M2 III and a hot dwarf and submerged in a cloud of the ionized gas of a planetary-nebula type. (auth)

6800 NONRADIAL OSCILLATIONS OF POLYTROPES. Robe, H. (Univ., Liege). Ann. Astrophys., 31: 475-82(Sept.-Oct. 1968). (In French).

The results of direct integration of the fourth- and second-order differential systems governing the nonradial adiabatic pulsations of polytropes are presented and discussed. The mode p_{10} to g_{10} belonging to the second-order spherical harmonics was determined for the polytropes n = 1; 2; 3; 3.25; 3.5; and 4; it is shown that the first modes of centrally condensed polytropes do exist but exhibit an irregular number of nodes. (auth)

6801 INFRARED SPECTRA OF M AND C STARS BETWEEN 4000 AND 9000 cm^{-1}. I. GENERAL DESCRIPTION. Connes, P.; Connes, J.; Bouigue, R.; Querci, M.; Chauville, J.; Querci, F. (Centre National de la Recherche Scientifique, Bellevue, France. Observatoire de Meudon, France. Observatoire de Toulouse). Ann. Astrophys., 31: 485-92(Sept.-Oct. 1968). (In French).

A first qualitative analysis of high-resolution infrared stellar spectra is given. In M-type stars, plenty of atomic lines were observed; $^{12}C^{16}O$ and $^{13}C^{16}O$ give the most intense molecular bands. On the other hand, for C stars, molecular features are more important; normal and isotopic CO, CN, C_2 are particularly visible. (auth)

6802 THE ORIGIN OF THE PECULIAR A STARS. Guthrie, B. N. G. (Royal Observatory, Edinburgh). Mon. Notic. Roy. Astron. Soc., 141: 269-70(1968).

Peculiar A stars are thought to have been secondaries in binary systems. It is concluded that the type-II supernova explosion theory, suggested by Van den Heuvel (1967), is consistent with a wide range of observations of peculiar A stars. (UK)

6803 EXPANDING ATMOSPHERES IN OB SUPERGIANTS. I. Hutchings, J. B. Mon. Notic. Roy. Astron. Soc., 141: 219-49(1968).

Radial velocity measurements were made on high dispersion plates of the Of stars HD 152408 and 151804, and the BI supergiant HD 152236. In all cases velocities differ between different ions and between strong lines of H and He(I), indicating the existence of extended accelerating atmospheres. In the O stars, P Cygni profiles indicate that the velocities reach 600 km/sec and beyond. Tentative temperature and velocity fields are proposed. (auth)(UK)

6804 THE ATMOSPHERE OF η AQUILAE. Dawe, J. A. Mon. Notic. Roy. Astron. Soc., 141: 185-207(1968).

A series of preliminary model atmospheres is presented for the

cepheid variable η Aquilae. It is shown how these models may be transformed, by inducing variations in their initial values of effective gravity and characteristic turbulent velocity, to yield the observed radial velocity curve for the absorption core of the K line of Ca(II) and the velocity gradient, $\partial V/\partial r$, in the vicinity of the layer of formation of the Fe(I) lines. These transformed models imply a stellar mass of $\geq 13\ M_\odot$ and turbulent velocities of about 14 km/sec at $\tau_5 \sim 0.1$ and 60 km/sec at $\tau_5 \sim 0.001$. It is suggested that the commencement of the pulsation in each atmospheric stratum is coincident with the passage of some disturbance, identifiable with the emission component of Ca(II) K seen by Jacobsen (1956), which, though initially subsonic, is rapidly accelerated upwards to become a shock wave. Various processes of mass loss for the star are discussed and it is concluded that the effects of mass exchange must be accounted for when computing evolutionary models for cepheid stars. (auth)(UK)

6805 INFLUENCE OF INHIBITION OF CONVECTION ON PRE-MAIN SEQUENCE STELLAR EVOLUTION. Moss, D. L. (Univ. of Sussex, Brighton, Eng.). Mon. Notic. Roy. Astron. Soc., 141: 165-84(1968).

The effects on the pre-main sequence evolution of a star of one solar mass of inhibiting convection by arbitrarily changing the critical temperature gradient for convective instability are investigated. It is found that models which are largely radiative, and hence of low surface temperature at large radii, can be constructed. The inclusion of a high surface opacity is found to enhance the effects produced by inhibiting the convection. (auth)(UK)

6806 PHOTOGRAPHIC PHOTOMETRY OF STARS IN NGC 457. Jones, David O. M.; Hoag, A. A. (Kitt Peak National Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac., 80: 531-43(Oct. 1968).

The images of 171 stars in the field of the previously well-observed open cluster, NGC 457, were measured using U, B, and V plates obtained with the 84-inch reflector. The primary purpose was to test the suitability of the telescope and iris photometer for photographic photometry and to provide material for use in developing machine reduction routines for handling measures of direct plates. (auth)

6807 ABUNDANCE HOMOGENEITY AND ABSOLUTE MAGNITUDES OF THE HYADES MOVING GROUP. Breger, Michel (Univ. of California, Berkeley). Publ. Astron. Soc. Pac., 80: 578-88(Oct. 1968).

The Hyades moving group shows a distribution of m_1 metal-abundance indices intermediate between the Hyades-cluster and field-star distributions, indicating a mixture of both. Group parallaxes give a mean absolute magnitude brighter by 0^m3 than is obtained from the Strömgren c_1 index, while for the Hyades cluster the agreement is very good. Several possible reasons for this are discussed. It is recommended that membership in moving groups should not be used to obtain absolute magnitudes for any individual star. (auth)

6808 PRE-OUTBURST SPECTRA OF NOVA RS OPHIUCHI 1967. Wallerstein, George; Cassinelli, Joseph P. (Univ. of Washington, Seattle). Publ. Astron. Soc. Pac., 80: 589-96 (Oct. 1968).

Spectra of RS Ophiuchi taken between 1964 and 1967 are described. Radial velocities and line lists with identifications are presented. Although the velocities and line strengths change in detail from year to year, there are no clues provided to predict a new outburst. The spectrum appears to be that of a shell and the nature of the underlying stars is not revealed. (auth)

6809 ABSOLUTE MAGNITUDES OF CARBON STARS. Gordon, Courtney P. (Univ. of Michigan, Ann Arbor. Kitt Peak National Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac., 80: 597-611(Oct. 1968).

The visual absolute magnitudes of carbon stars were determined using double stars, carbon stars in clusters, and the Wilson–Bappu effect. Combining these magnitudes with previous results for carbon stars in the Large Magellanic Cloud and from radial-velocity and proper-motion studies. Average visual absolute magnitudes for R stars of $+0^m4$, and for N-M3.5 to N-M6 stars of -1^m5 to -3^m5 as a function of spectral type were obtained. The bolometric absolute magnitudes of R stars are close to those of K giants while the N stars are distinctly brighter than M giants, falling in luminosity class II. (auth)

6810 PHOTOELECTRIC OBSERVATIONS OF AN SERPENTIS. Basu, B. (Univ. of California, Berkeley). Publ. Astron. Soc. Pac., 80: 612-16(Oct. 1968).

A new time of maximum was obtained for AN Serpentis. The light curve shows no hump on the declining branch as was suggested by Spinrad. The hump observed by him was probably due to some atmospheric or instrumental effect. (auth)

6811 A NOTE ON AT HERCULIS. Basu, B. (Univ. of California, Berkeley). Publ. Astron. Soc. Pac., 80: 616-18 (Oct. 1968).

AT Herculis was observed in the UBV photometric system. The observational data indicate the star does not belong to the RR Lyrae class of variables, and its period cannot be as short as 0^d33 as given in the General Catalogue of Variable Stars. (auth)

6812 INFRARED OBJECT IN THE REGION OF IC 1805. Maffei, Paolo (Laboratorio di Astrofisica, Frascati, Italy). Publ. Astron. Soc. Pac., 80: 618-21(Oct. 1968).

An infrared object was discovered during a study of T Tauri objects and diffuse nebulae, on plates of the field of IC 1805. The object appears compact and elliptical. The peculiarity of the object is its pronounced brightness in infrared radiation with invisibility in blue light. (W.D.M.)

6813 PROTOSTARS AS SOURCES OF ANOMALOUS OH EMISSION. Mezger, P. G. (National Radio Astronomy Observatory, Green Bank, W. Va.); Robinson, B. J. Nature (London), 220: 1107-10(Dec. 14, 1968).

Several lines of investigation suggest that the OH condensations are protostars associated with recently formed O stars. (auth)(UK)

6814 VARIABILITY IN MAGNETIC STARS. Browne, P. F. (Univ. of Manchester, Eng.). Nature (London), 220: 1296-8 (Dec. 28, 1968).

Problems raised by these stars can be understood if the absorption line spectrum originates in different layers of a circumstellar envelope as a compression wave propagates through the envelope. (auth)(UK)

Quasi-Stellar, Radio, and X-Ray Sources

6815 PHASE STABLE INTERFEROMETER OF 100,000 WAVELENGTHS BASELINE. Basart, J. P.; Clark, B. G.; Kramer, J. S. (National Radio Astronomy Observatory, Green Bank, W. Va.). Publ. Astron. Soc. Pac., 80: 273-80(June 1968).

Fringe visibilities of 23 radio sources measured with an interferometer of 100,000 wavelengths baseline are presented. The interferometer consists of a 42-foot (12.7 meter) portable telescope and one element of the NRAO three-element interferometer. (auth)

6816 FARADAY ROTATION OF RADIO WAVES FROM THE PULSARS. Smith, F. G. (Univ. of Manchester, Jodrell Bank, Eng.). Nature (London), 220: 891-2(Nov. 30, 1968).

The discovery of a linearly polarized component of the radiation from pulsars led to an attempt to measure the Faraday rotation of the plane of polarization as the radio waves traversed the ionized interstellar gas, in the expectation that the result could be used to find a value for the interstellar magnetic field. Using 151-MHz radio waves from the pulsar CP 0950, a surprisingly small Faraday rotation was found, consistent with a field $< 2 \times 10^{-7}$G; it was surmised that this result might have been peculiar to the particular line of sight. Measurements are now reported for several other pulsars (CP 0328 and AP 2015 + 28), indicating much larger Faraday rotations. Both of these sources lie at low galactic latitudes. Measurements were made by recording the difference in power received in orthogonal dipoles in a rotatable mount at the focus of the Mark I 250-ft telescope. A receiver bandwidth of 750 kHz was used, and the polarization determined in two bands separated by between 1.0 and 3.0 MHz, using center frequencies of 151.5 and 408 MHz. As the feed was rotated, a sinusoidal variation of the difference was recorded, and any phase shift between the sinusoids for the two frequencies was attributed to Faraday rotation, which varies as the inverse square of the frequency. Repeat measurements on CP 0950 again showed no detectable Faraday rotation. Comparison with data for the sources 3C 86 and 410 may imply that rotation is occurring in parts of the Galaxy beyond the pulsars, and the rotation measure of the pulsars as compared with nearby extragalactic sources may provide an indication of their distances. (UK)

6817 COSMIC X RAYS. Friedman, H. (Naval Research Lab., Washington, D. C.). Nature (London), 220: 862-5(Nov. 30, 1968).

Searches for cosmic x-ray sources have led to a development of a new branch of astronomy. An outline is given of Dr. Friedmans talk about this subject at a meeting on cosmic x-ray astronomy held at the Royal Society (London) on November 27, 1968. (auth) (UK)

6818 INTENSITY VARIATIONS OF THE PULSAR CP 1919. Lovelace, R. V. E.; Craft, H. D. Jr. (Arecibo Ionospheric Ob-

servatory, Puerto Rico). Nature (London), 220: 875-9(Nov. 30, 1968).

Inference about the origin of the variations are drawn from measurements of intensity distributions, power spectra, and cross correlations between several frequencies. (auth) (UK)

6819 UPPER LIMITS TO GAMMA-RAY FLUXES FROM THREE PULSATING RADIO SOURCES. Fazio, G. G.; Helmken, H. F.; Rieke, G. H.; Weekes, T. C. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Nature (London), 220: 892-3 (Nov. 30, 1968).

A survey of possible celestial gamma-ray sources was undertaken by the measurement of Cherenkov light generated in the atmosphere by energetic particles in air showers. Upper limits for 13 possible continuous sources of gamma rays of energy $>2 \times 10^{12}$ eV had already been reported; with the discovery of pulsars, however, the survey was extended to include observations of these objects, and results of these observations are reported. Most of the observations were made at the Mount Hopkins observing station (4,200 ft) near Tucson, Arizona, by means of light detectors consisting of two 5-ft searchlight mirrors with RCA 4518 photomultipliers at their foci, operated in coincidence with a resolving time of 6 ns. The results of eleven drift scans on CP 0950, 1133, and 1919 are presented. An attempt was also made to detect periodicity in any possible gamma-ray emission from the pulsars, under the assumption that gamma rays are emitted only during radio pulses. Some observations were also made at the 7,600-ft level of Mount Hopkins. The observations gave no evidence of a high-energy gamma-ray flux. (UK)

6820 5 GHz CONTINUUM RADIATION FROM SOUTHERN HEMISPHERE GALACTIC HII REGIONS. Gardner, F. F.; Morimoto, M. (CSIRO, Epping, New South Wales). Aust. J. Phys., 21: 881-94(Dec. 1968).

The continuum radiation from about 36 southern thermal radio sources was surveyed at 6-cm wavelength with a beam width of 4.2′ arc, and maps are shown for 28 of these. The positional accuracy is better than 1′ arc. All the sources are resolved to some extent. Peak temperatures, half-intensity widths, and peak emission measures are given for each. (auth)

6821 STUDY OF A COMPLETE SAMPLE OF COSMIC RADIO SOURCES. Davidson, W. (Univ. of Otago, Dunedin, New Zealand). Aust. J. Phys., 21: 871-80(Dec. 1968).

An examination was made of the red shifts and intrinsic powers of the identified radio sources in a complete sample taken from the Cambridge 3C Revised catalog. The sample consists of the 89 sources of the catalog having flux density $S_{178} \geq 15 \times 10^{-26}$ W m^{-2} Hz^{-1} and $|b^{II}| > 15°$, of which 71 are now identified. The subset of the sources having $S_{178} \geq 30 \times 10^{-26}$ W m^{-2} Hz^{-1}, in which there are 23 sources with 22 identified, was also considered. Where red shifts for the radio sources were not available (in 16 cases out of the 71 identified) these were calculated from the observed visual apparent magnitudes using the Einstein–de Sitter cosmology, and alternatively, the Milne cosmology. The intrinsic powers of the sources at 178 MHz were calculated for the same two universes, using the given flux density and red shift with an assumed power spectrum common to all sources. The resulting information presents new evidence on the nature of the local luminosity distribution and the local luminosity function of the sources. In addition, observed distributions of red shift and luminosity such as are found here are likely to be of critical importance in future testing of evolutionary schemes designed to interpret the radio source counts. (auth)

6822 OBSERVATIONS OF THE SOUTHERN SKY AT 10.02 MHz. Hamilton, P. A.; Haynes, R. F. (Univ. of Tasmania, Hobart). Aust. J. Phys., 21: 895-902(Dec. 1968).

The brightness distribution of cosmic radio noise was surveyed at 10.02 MHz between declinations −2° and −65° with an aerial beam of 4° by 5°. The galactic plane appears as a region of low brightness. Spectra of sources observed are discussed. (auth)

6823 ACCURATE POSITIONS AND IDENTIFICATIONS OF 75 RADIO SOURCES BETWEEN DECLINATIONS $+20^0$ AND $+27^0$. Merkelijn, Jeannette K. (CSIRO, Epping, New South Wales). Aust. J. Phys., 21: 903-16(Dec. 1968).

Accurate positions were obtained for 75 sources between declinations +20° and +27°. For most sources the estimated error is less than 15″ arc in each coordinate. Identifications are suggested for 27 sources from inspection of the Palomar Sky survey prints near the new positions. Fourteen of the suggested identifications are galaxies and 13 are quasi-stellar objects. (auth)

6824 PULSARS AND SUPERNOVAE. Sky Telesc., 37: 3; 24(Jan. 1969).

The evidence connecting rapidly pulsating radio sources and supernovae explosions is reviewed. Two cases of such association have recently been announced, involving the pulsars PSR 0833-45 in the southern constellation Vela and NP 0532 in Taurus. (W.D.M.)

6825 SEARCH FOR AN EFFECT OF MASS ON FREQUENCY DURING A CLOSE APPROACH OF PULSAR CP 0950 TO THE SUN. Sadeh, D. (Naval Research Lab., Washington, D. C.); Hollinger, J. P.; Knowles, S. H.; Youmans, A. B. Science, 162: 897-8(Nov. 22, 1968).

Observations of the pulse arrival times from the pulsar CP 0950 were made during August when the line of sight to the pulsar approached within 5 degrees of the sun in order to test a suggested mass-on-frequency effect. The observations do not show evidence for the predicted effect. (auth)

6826 FORMULAS, GRAPHS, AND TABLES FOR A QUANTITATIVE ANALYSIS OF THE HYDROGEN RADIATION OF EMISSION OBJECTS. Boyarchuk, A. A.; Gershberg, R. E.; Godovnikov, N. V. Izv. Krym. Astrofiz. Observ., 38: 208-18(1967)(Publ. 1968). (In Russian).

Working formulas, graphs, and tables, necessary for a quantitative analysis of the hydrogen radiation in emission objects are given. The results are made more precise and handy graphs for a quick analysis of continuous and linear hydrogen emission are given. (auth)

6827 ON THE OPTICAL THICKNESS OF RADIATING, COOLING, AND EXPANDING HYDROGEN CLOUD FOR RADIO FREQUENCIES. Gershberg, R. E. Izv. Krym. Astrofiz. Observ., 38: 205-7(1967)(Publ. 1968). (In Russian).

On the basis of studies by Gershberg (1966), where there are calculations of physical conditions in radiating, cooling, and expanding hydrogen clouds, variations of the optical thickness of such a nonstable gaseous body for radio frequencies are given. (auth)

6828 NEW RADIOTELESCOPE OF THE CRIMEAN ASTROPHYSICAL OBSERVATORY WITH THE 22-m PARABOLIC REFLECTOR. Ivanov, V. N.; Moiseev, I. G.; Monin, Yu. G. Izv. Krym. Astrofiz. Observ., 38: 141-8(1967)(Publ. 1968). (In Russian).

The new radiotelescope with the reflector diameter of 22 m, built at the Crimean Astrophysical Observatory, is described. The high precision of the manufacturing of the reflector surface, a hard frame of the reflector and all constructions, as well as the precision of the work of the digital system of the automatic control allow observations of radio sources at the range of mm waves. (auth)

6829 METHOD OF DETERMINATION OF THE ELECTRON TEMPERATURE OF HII REGIONS. Courtes, G.; Louise, R.; Monnet, G. (Observatoire de Marseille). Ann. Astrophys., 31: 493-9(Sept.-Oct. 1968). (In French).

This paper is devoted to a high-resolution interference method of determining the electron temperature of H II regions, obtained by means of the H_α (6563 Å) and [N II] (6584 Å) line widths. The interest of using line profiles and not the classical methods about the intensities of lines in the determination of the electron temperature is emphasized. The choice of the H_α and [N II] 6584 Å lines practically allows cancellation of all of the broadening effects other than the kinetic one. Two different optical sets were used and their respective advantages are discussed. The first measurements on Orion, IC 405, and NGC 1499 are given. The electron temperatures are obviously less than 10,000°K. On the contrary, a very high temperature, 14,000°K, is shown on the bright rim (NGC 7000) south of America. (auth)

6830 OPTICAL POSITIONS OF RADIO GALAXIES AND QUASARS. Veron, P. (Observatoire de Paris-Meudon, France). Ann. Astrophys., 31: 483-4(Sept.-Oct. 1968). (In French).

Optical positions were determined for 19 radiogalaxies and quasars with the 48-inch Schmidt telescope at Palomar. (W.D.M.)

6831 PLANETARY NEBULAE AS POSSIBLE X-RAY SOURCES. Khromov, G. S. (Sternberg State Astronomical Inst., Moscow). Nature (London), 220: 1111(Dec. 14, 1968).

The problem of the identification of galactic x-ray sources in the energy interval 4 to 8 keV is discussed, with reference to the possibility of identifying them with planetary nebulae. In such a system x-ray emission could originate both in the nebula and in its contained very hot star. The following mechanisms are considered: (a) black body radiation of the nucleus; (b) thermal radiation of a hot corona; (c) synchrotron emission of relativistic electrons; and (d) the inverse Compton effect in the scattering of fast electrons by photon radiation in the nebula. Of these mech-

anisms (d) appears the most favorable, and is further discussed; but there is a contradiction between calculated energy requirements and the modern view of the energetic equilibrium of galactic subcosmic rays. Statistics of the x-ray sources were compared with those of the planetary nebulae, and appeared to coincide rather well. (UK)

6832 FURTHER OBSERVATIONS OF THE γ-CYGNI RADIO SOURCE. Higgs, L. A.; Halperin, W. Mon. Notic. Roy. Astron. Soc., 141: 209-17(1968).

New radio observations of the "γ-Cygni" source in the Cygnus X complex were made at wavelengths of 9.3 cm and 2.8 cm using a 10- and 46-m antenna, respectively. These support earlier conclusions that this strong radio source is of a nonthermal nature. In addition, there is evidence that it is weakly (<2%) but significantly polarized at both wavelengths. The source consists of a strong feature of small angular size (<3′) superimposed upon an extended region of emission, which contributes the major portion of the observed flux density. The strong feature corresponds very well in position with the optical nebulosity near the γ-Cygni. The weaker extended component resembles an incomplete ring of about 8′ diameter. It is suggested that this is a supernova remnant at a distance of ~3 kpc. The question whether the γ-Cygni nebulosity is associated with this postulated supernova remnant, or with the star γ-Cygni, is discussed. (auth)(UK)

6833 OBLIQUE ROTATOR AND PULSAR RADIATION. Eastlund, Bernard J. (Atomic Energy Commission, Washington, D. C.). Nature (London), 220: 1293-6(Dec. 28, 1968).

A model is proposed by which stars with a dipole magnetic field oriented at an angle to the rotation axis may emit pulsating radio signals. (auth)(UK)

6834 CHEMICAL EXCHANGE REACTIONS AND H_2 FORMATION IN DARK INTERSTELLAR CLOUDS. Solomon, P. M. (Columbia Univ., N. Y.); Wickramasinghe, N. C. Nature (London), 220: 1214-15(Dec. 21, 1968).

Some serious deficiencies are pointed out in the explanation proposed by Stecher and Williams (Nature 219: 1349(1968)) for lack of 21-cm radiation in the dark clouds, on the basis of the formation of molecular H_2. These deficiencies arise in the mathematical treatment, and in the neglect of photodissociation; also in the argument against the possibility of H_2 formation by physical adsorption processes on grain surfaces. The calculations of the present authors indicate that the latter formation mechanism is plausible. (UK)

6835 INTERSTELLAR MAGNETIC FIELDS DETERMINED FROM ZEEMAN EFFECT MEASUREMENTS. Davies, R. D.; Booth, R. S.; Wilson, A. J. (Univ. of Manchester, Jodrell Bank, Eng.). Nature (London), 220: 1207-10(Dec. 21, 1968).

It is stated that the Zeeman splitting of the 21 cm line in interstellar neutral hydrogen clouds provides the only direct measure of the line of sight component of the magnetic fields in the interstellar medium. Earlier studies of the Zeeman splitting are briefly outlined, and a series of observations made during June to Oct. 1968 using the Mark II radiotelescope, are described. The observations were concentrated on the absorption spectrum of Cas A, which shows the strongest spectral features in the 21-cm line. In discussing the results the Perseus arm and Orion arm absorption features are considered separately, since it is probable that they are significantly different samples of the interstellar medium. Comparison is made with results of Faraday rotation measurements. The new measurements, with improved sensitivity and data reduction technique, confirmed that in the direction of the Perseus arm there is a field strength of 10 to 20 μG. A more extensive mapping of the galactic magnetic field may be made possible by such Zeeman measurements. (UK)

6836 DIRECT COMPARISON OF MOTIONS OF NEUTRAL AND IONISED HYDROGEN IN THE GALAXY. Kerr, F. J. (Univ. of Maryland, College Park); Burke, B. F.; Reifenstein, E. C.; Wilson, T. L.; Mezger, P. G. Nature (London), 220: 1210-11 (Dec. 21, 1968).

Observations of the radio recombination lines of hydrogen provide a new method for measuring velocities of regions of ionized hydrogen, and the transparency of interstellar dust to radio waves makes the method applicable to the whole Galaxy. A detailed comparison between the velocities of neutral and ionized hydrogen is of intrinsic interest, and the H(II) component can be taken as an indicator of young stars. Other work in connection with H(I)–H(II) comparisons is briefly reviewed, and new possibilities are discussed for comparisons provided by radio recombination line observations of H(II) regions. If it could be established that H(I) and H(II) have kinematic similarities the solution of various problems would be greatly helped. In this connection observations of galactic H(I) made with the CSIRO 210-ft telescope at Parkes, N.S.W., were examined, together with radial velocity measurements on discrete H(II) regions at H 109 α by the NRAO–MIT group in America. It appeared from the results that systematic velocity differences between the average motions of H(I) and H(II) are <10 km/sec, and that in the Galaxy outside the expansion zone H(I) and H(II) follow the same dynamics. The H(II) can be taken as representative of young stars in location and motion; hence there is no systematic difference between the motions of the neutral gas and the young stars. The similarity of kinematics also implies similarity of location of the H(I) and H(II) to a first order, although important differences exist. (UK)

Solar Phenomena

Refer also to abstract 6898 and 7117.

6837 TEMPERATURE STRUCTURE AND ENERGY BALANCE IN THE SOLAR CHROMOSPHERE. Jordan, Stuart Davis. Boulder, Colo., Univ. of Colorado, 1968. 231p.

Thesis.

A new approximate method is developed for calculating the temperature distribution in an atmosphere in which local mechanical energy dissipation is balanced by local net radiative loss in one or more spectral lines in which the atmosphere is optically thick. The method uncouples the equations of radiative transfer for the individual spectral lines from the energy conservation equation and from each other. This permits a solution of each individual transfer equation for the radiation field in each line. These results, combined with the energy conservation equation, yield the temperature distribution in the atmosphere, provided that the optical depth ratio of the spectral lines is known at each point. The temperature distribution in the solar chromosphere is calculated up through the region losing energy in the Ly α line of hydrogen, using the above method. (Diss. Abstr.) (TSS)

6838 PHOTOELECTRIC ECLIPSE OBSERVATIONS OF CONTINUUM AND CORONAL LINE EMISSION AT THE SOLAR LIMB. Weart, Spencer Richard. Boulder, Colo., Univ. of Colorado, 1968. 141p.

Thesis.

A photoelectric spectrometer was used at the total solar eclipse of November 12, 1966, at Huachacalla, Bolivia. A small slit was placed radial to a solar image and parallel to the direction of motion of the lunar image. Light admitted by the slit was dispersed by a plane grating so that five photomultipliers and a PbS infrared detector received selected slices of the spectrum. A typical photomultiplier saw both a line and the nearby continuum, separated by a chopping scheme. Outputs of the photomultipliers were automatically switched through five stages of sensitivity, making the response linear for light levels ranging over four orders of magnitude. At low light levels the limit of sensitivity was set by photon shot noise. The surface brightness of the red and green coronal lines of highly ionized iron and the brightness of 1½-Å wide slices of continuum near 5278 and 6406 Å is discussed for the region from 10,000 km above the limb of the Sun down onto the disc. The lines appear to be brighter than would be the case if all emission arose in levels above 9000 km; it is suspected that coronal emission is found at least as far down as 4000 km. In the continua, the limb-darkening curves agree with other observers' results on the solar disc. (The roughness of the lunar limb is taken into account, and is found to have little effect on the results). Above the level where radial optical depth at 5000 Å is unity—a point 250 km below the height zero conventional for eclipse work—the surface brightness falls with slowly decreasing scale height (as low as 50 km) for about 700 km. Then there is an abrupt break in the curve; the surface brightness falls very slowly for the next 1000 km. This sharp break and plateau are not predicted by existing models of the solar atmosphere. It is argued that the small scale height immediately below the break (where radial optical depth is around 10^{-5}) implies that most electrons in that region come from metal ionization, and hence that the temperature there is under 5000°K, while at the break the atmosphere probably heats up rapidly to over 6000°K. (Diss. Abstr.)

6839 STRUCTURE, DYNAMICS, AND EVOLUTION OF SOLAR CORONAL STREAMERS. Bohlin, John David. Boulder, Colo., Univ. of Colorado, 1968. 237p.

Thesis.

The morphology, evolution, and associated phenomena of streamers seen in the white-light solar corona are discussed. The investigation used a combination of coronal observations which together afforded hitherto unavailable time and spatial resolution. Twelve coronal streamers were identified, using the 1965 solar eclipse and three stratospheric balloon flights of an externally occulted coronagraph. These streamers were located on the disk of the Sun

using the nearly daily observations of the inner K corona ($r \leq 1.75$ solar radii) from a ground-based coronagraph. The morphology and evolution of streamers were then determined from cross correlation of coronal and solar activity data. (TSS)

6840 THE MONOCHROMATIC SUN IN THE EXTREME ULTRAVIOLET. Boardman IV, William Jarvis. Boulder, Colo., Univ. of Colorado, 1968. 204p.

Thesis.

Spectroheliograms of the Sun taken during an Aerobee rocket flight made on April 28, 1966, by the U. S. Naval Research Laboratory give a resolution of the solar disk of 10″ of arc in the spectral region 170 to 630 A. Although a considerable amount of overlap of the solar images in the various emission lines is evident, active regions are clearly distinguishable particularly in the lines of Fe IX to XIV, Mg IX, and Si XII. The degree of localization of emission shows a definite increase with increasing temperatures characteristic of the ions responsible for the emission. Two features near the east limb of the Sun were sufficiently free from contamination by background continuum and overlapping by other features to permit measurements of their maximum brightnesses in the various lines. For one of these two features, the associated chromospheric emission was just barely occulted by the solar limb, thus the observed emission was purely coronal. This feature was selected for a photometric study and an investigation of its structure. (Diss. Abstr.) (TSS)

6841 CHROMOSPHERIC HYDROGEN SPECTRUM AT THE 1962 SOLAR ECLIPSE. Henze, William Jr. Boulder, Colo., Univ. of Colorado, 1968. 160p.

Thesis.

An expedition to New Guinea observed the chromospheric spectrum during the solar eclipse of 4–5 February, 1962, with two slitless spectrographs covering the wavelength range from 3200 to 9100 Å; the calibration utilized the solar disk as a standard source. The thesis is primarily concerned with the hydrogen data on the spectrograms; however, a description is also included of the overall reduction program which yielded intensities of all the lines at all heights observed. (Diss. Abstr.) (TSS)

6842 SUB-MILLIMETRE WAVE SOLAR OBSERVATIONS. Gebbie, H. A.; Chamberlain, J.; Burroughs, W. J. (National Physical Lab., Teddington, Eng.). Nature (London), 220: 893–5 (Nov. 30, 1968).

A sub-millimetre wave observation of the Sun, obtained in Dec. 1967 at 3,580 m, indicated an unexpected absorption feature in the range 7 to 9 cm^{-1}, confirming an earlier result obtained in March 1957 at the same site. Because of the long atmospheric path during the more recent observations, spectral quality was modest, and in order to obtain better results further observations were made in April 1968, when the air mass in the observation path was smaller and comparable with that of March 1957. The 30-cm coelostat at Jungfraujoch was employed to collect the solar radiation, and the radiation was modulated by means of an oscillating secondary mirror which scanned from Sun to sky at 10 Hz. This completely eliminated problems caused by radiation exchange between the detector and the cold sky, thus practically doubling the time available for observation. The spectrum obtained on April 11, 1968 is shown, and some important observational results are discussed. The anomalous absorption region around 9 cm^{-1} was confirmed, and a new anomalous absorption feature consisting of two components was clearly indicated in the 21 to 24 cm^{-1} region. The latter is discussed in relation to atmospheric water vapor content. A possible explanation for this new feature might be found in unidentified dimeric atmospheric constituents, such as $(H_2O^{16})_2$, which has already been invoked to explain the 7 to 9 cm^{-1} feature and which could be expected to show a stronger feature at 21 to 27 cm^{-1}. (UK)

6843 MAGNETIC FIELDS OF SOLAR FACULAE. Steshenko, N. V. Izv. Krym. Astrofiz. Observ., 38: 52–8(1967)(Publ. 1968). (In Russian).

Strengths of a magnetic field longitudinal component of facular granules were measured using spectrograms with high resolutions obtained at the Crimean Astrophysical Observatory and Mount Wilson Observatory. It was found that magnetic field strength $H_{||}$ of about 45% of facular granules is within the limits of measuring errors (approximately 25 G). $H_{||}$ of about a quarter of facular granules are from 25 to 50 G, ~30% of facular granules have $H_{||} >$ 50 G, and sometimes there are faculae with field strength of about 200 G. Facular magnetic fields are concentrated in fine elements by dimension of 1.5 to 3″ only. The magnetic field strength of facular granules, situated directly above spots, is 10 to 20 times less than the field strength of spots and equal to 80 to 210 G only. It can be explained by "a streamline" of a facula by magnetic lines of force and slow penetration of a field deep into a facula in connection with a large conductivity of plasma. (auth)

6844 X-RAY LINE AND CONTINUUM SPECTRA OF SOLAR FLARES FROM 0.5 TO 8.5 ANGSTROMS. Meekins, John F.; Kreplin, Robert W.; Chubb, Talbot A.; Friedman, Herbert (Naval Research Lab., Washington, D. C.). Science, 162: 891–5 (Nov. 22, 1968).

Two crystal spectrometers aboard the orbiting solar observatory OSO-4 cover the wavelength ranges 0.5 to 3.9 Å and 1.0 to 8.5 Å. Within this range, there appear emission lines from hydrogen-like and helium-like states of calcium, sulfur, silicon, magnesium, and aluminum. The Mg XII Lyman-α is present strongly in all x-ray flares. The most intense flares (such as class 3) produce strong Si XIV Lyman-α and often S XVI Lyman-α. Emission in the form of Kα lines of highly ionized states of calcium, iron, aluminum, and silicon is usually present. The continuum from 1 to 10 Å always dominates the line emission by more than an order of magnitude. Electron temperatures derived from the slope of the continuum spectrum are in the range of 10^7 to $10^{8.5}$K, considerably higher than theoretical ionization equilibrium temperatures. (auth)

6845 MAGNETIC ASYMMETRY AND VARIATIONS OF THE GENERAL MAGNETIC FIELD OF THE SUN. Severnyi, A. B. Izv. Krym. Astrofiz. Observ., 38: 3–51(1967)(Publ. 1968). (In Russian).

The influence of the resolving power of the magnetograph on the results of statistics — mean field strength $\bar{H}$, the average length $\bar{\lambda}$, and the number of magnetic elements $\bar{n}$ of different polarity was examined. It is shown that while the net magnetic flux and $\bar{n}$ remain unchanged the mean field strength of a given sign increases by a factor 1.3 to 1.4, and the length $\bar{\lambda}$ decreases by a factor 1.2 to 1.3 when resolution increases from 27″ to 2″.5. It is also shown that with the resolution 23″ × 23″ (routine Mount Wilson records) about 50% of all elements of the general magnetic field with the length <10″ are not recorded (below noise level), while less than 10% of the elements with the size <3″ are lost at the Crimean routine records of the field (resolution 2″.5 × 9″). Twenty-four magnetographic records of N- and S-polar regions (latitudes 55 to 75°, longitudes ± 25°) made in 1965 were measured and analyzed. (W.D.M.)

6846 VARIATION OF MAGNETIC FIELDS OF SUNSPOTS IN TIME. Kolpakov, P. E. Izv. Krym. Astrofiz. Observ., 38: 59–64(1967)(Publ. 1968). (In Russian).

Variations of the magnetic field of sunspots in time apparently determine a development of many nonstationary processes in active regions on the Sun. An attempt to estimate $\Delta H/\Delta t$ of a magnetic field of active spot groups at the photosphere level was made, using the data obtained with the magnetograph of the Crimean Astrophysical Observatory. According to the numerical value of $\Delta H/\Delta t$, variations of the magnetic field of sunspots can be subdivided into three types: (a) moderate, $\Delta H/\Delta t \sim 10^{-4}$ to 5×10^{-3} G/sec; (b) fast, $\Delta H/\Delta t \sim 5.01 \times 10^{-3}$ to 5×10^{-2} G/sec; (c) superfast, $\Delta H/\Delta t > 5.01 \times 10^{-2}$ G/sec. (auth)

6847 PECULIARITIES OF VELOCITY FIELDS IN A DEVELOPED ACTIVE REGION. Gopasyuk, S. I. Izv. Krym. Astrofiz. Observ., 38: 65–77(1967)(Publ. 1968). (In Russian).

Thirty-eight series of photoelectric recordings of photospheric radial velocities in a developed active region were studied. The recordings were obtained by means of the magnetograph in Fe I line λ5250 from Sept. 2–7, 1961, when the active region passed across the solar disk from E 30° to W 42°. It is shown that radial velocities, averaged over many recordings for every day, i.e., "quasi-stationary" velocities, differ from zero in that place, where the magnetic field strength is relatively large. With that the velocity can change sign within the limits of one polarity region. For the active region as a whole two types of "quasi-stationary" motions are picked out: one type is with mainly horizontal velocity directions and the second one — with mainly vertical velocity directions (in the main, downward). Quickly-changed disturbances, the maximal velocity amplitudes of which in some places are equal to 1400 m/sec, are superimposed on both types of motions. Motions with mainly horizontal velocity directions cover districts of large spots and their surroundings. These are mainly the places, where the strength of the longitudinal component of the magnetic field is larger than that one of the transverse component, and their surroundings. Motions with mainly velocity directions downward cover districts of the active region, where the transverse magnetic field predominates. These districts coincide with the places of quicker decay of the active region: disappearance of spots, their magnetic fields and division of a penumbra. For districts with motions in mainly horizontal direction the flows of the descending gas are compensated practically completely by the flows of the ascending gas. On the contrary, the flows with the predominant downward movement of gas are not compensated at

all and can reach the value of $\sim 8.10^{40}$ atom/sec. One of the possible explanations of this inequality of gas flows is proposed. (auth)

6848 TWO TYPES OF CHROMOSPHERIC FLARES. Ogir M. B. Izv. Krym. Astrofiz. Observ., 38: 78-91(1967)(Publ. 1968). (In Russian).

Flares are divided into two types on the basis of the development and motion of flares relative to the magnetic field. Flares, developing in parallel to a neutral line of a longitudinal field and then retiring from it, refer to the first type; the second type includes flares, being in the development process in the form of a loop, which disposes across a neutral line and unites the regions of contrary polarities. A relation is noted of the appearance of both flare types and two principal types of configuration of sunspot groups: a) flares of the first type are connected in the main with groups, where strong spots of opposite polarity are close to each other and stretch along latitude; b) flares of the second type are connected with groups having considerable stretch along longitude. Powerful loop systems of active filaments going from the region of one polarity to the region of opposite polarity, are developed in spot configurations of the second type. Flares of the second type are developed at the base or along active filaments and are situated in the region of strong transverse fields. Very often, active filaments are situated also close to the direction of the transverse field. Flares of the first type are accompanied by bursts of radio emission of type-IV, but in the case of flares of the second type, these bursts do not take place. (auth)

6849 TIME VARIATIONS OF A CHROMOSPHERIC NETWORK. Novikov, S. B.; Tsap, T. T. Izv. Krym. Astrofiz. Observ., 38: 92-5(1967)(Publ. 1968). (In Russian).

Time variations of a chromospheric network were studied using K_{2v2} spectrobeliograms. It was found that the contrast and dimensions of a chromospheric network outside an active region change with the 11-year cycle of solar activity. It is noted that dimensions of a chromospheric network in the active region are larger than in the undisturbed one. (auth)

6850 LINE PROFILES OF BALMER SERIES, CAUSED BY A COMBINED ACTION OF BROADENING FACTORS. Kurochka, L. N. Izv. Krym. Astrofiz. Observ., 38: 96-119(1967)(Publ. 1968). (In Russian).

A critical analysis of principal works dedicated to broadening of spectral hydrogen lines by joined action of ions and electrons is given. A calculation of the broadening action of the Doppler effect was made using Stark profiles, computed by Griem. The tables allow to calculate the absorption coefficient in hydrogen lines, expanding by a combined action of ions, electrons, Doppler effect, radiation damping, and the one resulting from collisions with neutral particles. A broadening of Balmer line series in the solar photosphere is considered as an example. (auth)

6851 SMALL FLARE EFFECTS IN COSMIC RAYS ACCORDING TO MEASUREMENTS IN THE STRATOSPHERE. Vladimirskii, B. M. Izv. Krym. Astrofiz. Observ., 38: 132-40(1967)(Publ. 1968). (In Russian).

A study of measurements, carried out by Charahchjan et. al., (1964) by means of balloons in Murmansk and Mirny (Antarctica) shows that some hours after the beginning of a chromospheric flare (of importance $\geq 1^+$) the intensity of cosmic rays at depths of ≤ 20 g/cm^2 is on the average 3 to 4% (with an error not more than 0.5%) higher than during flights in quiet intervals. The increase with such an amplitude is discovered after flares, accompanied by weak effects of PCA type on the average of 12 hr after the beginning of a flare in H_α. The generation of cosmic rays on small scales takes place, apparently, in all flares. (auth)

6852 OBSERVATIONAL METHOD OF SOLAR RADIO EMISSION BURSTS BY SHARP-DIRECTIONAL ANTENNAS. Efanov, V. A.; Moiseev, I. G. Izv. Krym. Astrofiz. Observ., 38: 149-54 (1967)(Publ. 1968). (In Russian).

The method of the simultaneous recording of radio emission from five parts of an active region on the Sun by means of a parabolic aerial and a receiving-amplifying circuit is described. The multifrequency modulation at a receiver entry with a following demodulation by synchronous detectors is applied for the division of signals. Measurements are carried out at 8 mm with the 22-m radiotelescope of the Crimean Astrophysical Observatory, allowing observation of an area with a diameter of about 6′ and with resolution 1′.6. (auth)

6853 SOURCE CHARACTERISTICS OF TYPE IV BURSTS. II. STUDY OF SPECTRA; EFFECT OF PLASMA ON SYNCHROTRON EMISSION. Boischot, A.; Daigne, G. (Observatoire de Paris-Meudon, France). Ann. Astrophys., 31: 531-5(Sept.-Oct. 1968). (In French).

The spectrum of the moving type-IV burst of September 14, 1966 is interpreted as due to the effect of the plasma on the synchrotron mechanism. Results by Ramaty and Lingenfelter (1967) are used to find the theoretical spectrum which best fits the observed one. This allows one to determine the values of $(\alpha\gamma)$ and ν_c. Then, assuming an electron density in the source of 10^7 cm^{-3} it is possible to compute the Lorentz factor of the electrons and the intensity of the magnetic field. It is concluded that the burst is due to the emission of electrons of 2.5 MeV in a field of 0.8 gauss. If it is assumed that the three dimensions of the source are equal to that measured in the E-W direction, a density of 4,000 relativistic electrons/cm^3 is required to explain the observed flux density. These 2.5-MeV electrons do have lifetimes much longer than the duration of the burst, and it is admitted that the decay of the burst is mainly due to the decay of the magnetic field in the source. The existence of continuum bursts on decametric wavelengths seems to contradict the fact that synchrotron emission has a cutoff near 100 MHz. But there is no proof yet that the decametric bursts are just extensions of the metric and decimetric ones, and it is suggested that they are due to different mechanisms. (auth)

6854 THE STRUCTURE OF THE SOURCES OF STATIONARY TYPE IV BURSTS AND NOISE-STORM ENHANCEMENTS. Clavelier, B.; Jarry, M. F.; Pick, M. (Observatoire de Meudon, France). Ann. Astrophys., 31: 523-30(Sept.-Oct. 1968).

The sources of emission of noise storm enhancements and stationary type-IV bursts, observed sometimes at decimetric wavelengths and sometimes at metric wavelengths, present a double structure. The "tail" component of this double structure is most probably situated at a lower altitude than the "head" component. It then follows that for the sources of emission situated in the eastern hemisphere, the tail component is occulted. One observes a lateral movement towards the east of sources of emission having a velocity of some tens of kilometers per second. (auth)

6855 THERMAL UMBRAL MODEL OF A BASE SPOT BY CONTINUUM INFRARED SPECTROPHOTOMETRY. Henoux, J.-C. (Observatoire de Meudon, France). Ann. Astrophys., 31: 511-22(Sept.-Oct. 1968). (In French).

The relative umbral intensities of a large spot were measured in infrared light between 0.86 and 2.20 μ. These measurements are corrected for parasitic light which is photospheric scattered light. The relative intensities are computed for some umbral models and compared with the observed ones. The deep layers in Zwaan's model and in the Fricke and Elsässer's model are too hot. A model is found which gives good agreement between computed and observed intensities. (auth)

6856 CONTRIBUTION TO THE STUDY OF TURBULENCE IN THE SOLAR PHOTOSPHERE. Banos, G. (Observatoire de Meudon, France). Ann. Astrophys., 31: 501-10(Sept.-Oct. 1968). (In French).

Supposing that the velocity field in the solar photosphere can be divided into two components, one of microturbulence and another of convection, a study was made by numerical experiments of the Goldberg-Unno method for determining Doppler widths, as well as the errors resulting, in this method (a) from the presence of a notable convection, and (b) from the use of lines with a parameter $a = \gamma\lambda^2/4\pi c\Delta\lambda_D$ quite important, γ being the damping constant. The models of Milne-Eddington (M.E.) and Schuster-Schwarzschild (S.S.) and different "column models" with ascending hot elements and descending cold elements were used. It was thus found that Goldberg's method can be considered valid if (a) the measurements are made at $\Delta\lambda \leq \Delta\lambda_D$, (b) $a < 0.01$ and (c) the convection velocity is lower than 1 km/s. If these conditions are not fulfilled, the application of the method leads to an "apparent" decrease of the microturbulence with height. It was further found that the relation $[\Delta\lambda_D, r(v)]$, where $r = I_c - I_\lambda/I_c$ depends on the $v_t = V_t/\Delta\lambda_D$, where V_t is the convection velocity, as well as on the distribution function of velocities $\phi(V_t)$ ("column model"). Using these results, an attempt was made to interpret the observations of the infrared C I multiplet lines near λ10700 published by de Jager and Neven [1964]. The variation of the convection velocity V_t with cosθ was determined. Results are qualitatively in agreement with those found by other investigators, who have analyzed line "wiggles". Quantitatively the results depend on the distribution function $\phi(V_t)$. The analysis shows that the observed profiles can be suitably interpreted by convection, with the consequence that the decrease of microturbulence with height, deduced by Unno, can be considered fictitious. (auth)

6857 POLARIZATION BURSTS IN THE SUN OBSERVED AT MICROWAVE FREQUENCIES. Kaufmann, Pierre; Matsuura, Oscar T.; Mascaro, A. C. Monte; Mendes, Aracy M. (Mackenzie

Univ., Sao Paulo, Brazil). Nature (London), 220: 1298-1300 (Dec. 28, 1968).

There are microwave bursts not observable in the total flux from the Sun, but only in circular polarization. The production of these events in the Sun requires equivalent changes of the magnetic field imposed on the emission regions during the bursts. (auth)(UK)

6858 PREDICTION OF THE CORONAL STRUCTURE FOR THE SOLAR ECLIPSE OF SEPT. 22nd, 1968. Schatten, K. H. (Univ. of California, Berkeley). Nature (London), 220: 1211-13(Dec. 21, 1968).

A model by the author for determining the large scale structure of the coronal and interplanetary magnetic fields is described. The model has proved successful in describing the transition from small scale features observed in the photosphere to the much larger scale features observed in interplanetary space, and in comparisons with coronal green line intensities. A further evaluation of the model was made using the coronal structure revealed in eclipse photographs. (UK)

6859 ELECTROMAGNETIC RADIATION FROM SOLAR FLARES. Tandon, J. N.; Deshpande, S. D. (Univ. of Delhi). Nature (London), 220: 1213-14(Dec. 21, 1968).

Rocket and satellite observations of 10- to 100-keV x-ray emission, together with ground-based observations of cm-wavelength bursts, have thrown much light on electromagnetic emission by solar flares. It is widely believed that the cm emission occurs through synchrotron radiation, whilst the x-ray emission is from bremsstrahlung, and their correlations have been studied. The correlations are best for the first events in a flare; for subsequent events the correlations are not good. These correlations can be understood if both emissions are assumed to come from a common source, but this leads to various difficulties. An alternative is that the emissions arise through the same energetic electrons from different layers of the solar atmosphere; but the problem of correlation remains unresolved for the mechanisms so far proposed. In the present communication alternative mechanisms to explain the correlation are proposed. It is suggested that upward moving particles, after release from trapping on the magnetic lines of force and thereby generating a shock, emit microwave radiation in the lower corona by coherent plasma processes, while particles moving downward into the chromosphere radiate hard x rays by inverse Compton scattering. The flux of coherent plasma emission and that of the x rays are calculated. It is concluded that the same particle energy range is responsible for the 10- to 100-keV x ray and the cm emission from the flash phase of solar flares. (UK)

6860 DELAY BETWEEN SOLAR ACTIVITY AND DENSITY CHANGES IN THE UPPER ATMOSPHERE. Blum, Peter W. (Univ. of Bonn). Planet. Space Sci., 16: 1427-40(Dec. 1968).

Since 1958 it has been known that there exists a response time of the upper atmosphere to changes in solar activity. This response time is best described as the lag between the 27-day variation of solar decimeter flux and the observed density changes of the upper atmosphere. Roemer (1966) obtained a mean observational value for this lag of 1.0 ± 0.12 days. Volland's (1966) simplified version of the Harris–Priester model of the upper atmosphere is used to calculate the delay which can be expected from theory. Only the effect of solar euv radiation is taken into account. A possible influence of the corpuscular component of the solar radiation is not included in the estimate. The calculations are carried out for the Harris–Priester model with solar activity index $\bar{F} = 200$ and a variation of $\Delta F/\bar{F} = 0.1$. The resulting delay is 0.6 days. The calculated amplitude of the variations of the diurnal average temperatures during the solar 27-day cycle is in very good agreement with Jacchia's empirical formula. (auth)(UK)

6861 HYDROMAGNETIC INTERPLANETARY SHOCK WAVES. Lee, T. S.; Chen, T. (Univ. of Minnesota, Minneapolis). Planet. Space Sci., 16: 1483-1502(Dec. 1968).

The adiabatic motion of a hydromagnetic fluid behind a strong spherical fast shock wave is examined in the case when the ambient medium exactly follows prescriptions of Parker's (1963) solar-wind model for the far field and when the shock propagation is at a uniform velocity. In the analysis both the spiralling Archimedian magnetic field and the wind streaming of the interplanetary medium are considered. It is found that the magnetic field controls the wave details at the rear termination, where both the density and the magnetic field reach peak values, and that $\frac{3}{2}$ for the polytrope index represents a critical value for waves having divergent characterizations at the termination. The active kinking distortion of interplanetary flux lines by flare-induced blastwaves is considered. Representative waves corresponding to a 1200 km/sec-velocity shock wave are calculated. (auth)(UK)

6862 ISOTOPIC COMPOSITION OF SOLAR BERYLLIUM. Warner, Brian (Univ. of Texas, Austin). Publ. Astron. Soc. Pac., 80: 622-3(Oct. 1968).

It is shown that a substantial isotopic wavelength shift is predicted for the Be II resonance lines. From the comparison between solar and laboratory wavelength measurements of these lines and from inspection of available atlases of the solar spectrum, it is concluded that there is no evidence for ^{7}Be or ^{10}Be in the solar atmosphere. (W.D.M.)

Galaxies

6863 CLUSTERS ASSOCIATED WITH SUPERGIANT GALAXIES. Sastry, Gummuluru N. (Wesleyan Univ., Middletown, Conn.). Publ. Astron. Soc. Pac., 80: 252-62(June 1968).

New techniques were developed for a rough but rapid determination of position angle, ellipticity, compactness, and center of distribution of galaxies in a cluster. These methods were applied to clusters associated with supergiant (Morgan cD) galaxies. There is a strong tendency for the major axis of the distribution of galaxies to be oriented along the major axis of the cD galaxy. The relative compactness of brighter and fainter members indicates that the radio cD clusters are dynamically younger than the non-radio cD clusters. (auth)

6864 LINES OF GALAXIES FROM RADIO SOURCES. Arp, Halton (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Publ. Astron. Soc. Pac., 80: 129-54(Apr. 1968).

All E galaxies brighter than $m_{pg} = 15$ magnitude which are radio sources stronger than $S_{1410} = 5$ flux units were investigated. In essentially all cases there are lines of galaxies originating from these radio E galaxies. The typical case is that the largest galaxy in a cluster is a radio E, and the other bright galaxies in this cluster are aligned on either side of this central galaxy along the line of elongation of the radio components. It is argued that this general physical phenomenon can only be explained by having the line of galaxies, or their progenitors, ejected from the central galaxy along with the radio-emitting material. The red shifts of the galaxies in these lines exhibit ranges between 1000 and 3000 km/sec. This result necessitates either the drastic reduction of the presently accepted ages for the galaxies in the lines, by a factor of 100, or an interpretation of part of the red shift as non-Doppler. (auth)

6865 PHOTOGRAPHIC PHOTOMETRY IN NGC 628. Pronik, I. I.; Chuvaev, K. K. Izv. Krym. Astrofiz. Observ., 38: 219-28 (1967)(Publ. 1968). (In Russian).

NGC 628 was investigated from photographs, which were obtained using an image converter tube and 7 filters. The region of the nucleus of NGC 628 radiates the light, homogeneous in its spectral composition. Outside the most dense part of the galaxy the radiation is less intense almost by one order, and a part of the ultraviolet radiation increases in it. The radiation in this region changes more smoothly with the distance from the center. Sixty H II regions, in which the radiation in H_α filter exceeds considerably the radiation in all other filters, are noted at the distance from 1 to 7 kps from the galactic center. Masses of diffuse nebulae luminous in H_α line, change from 10^4 to 10^6 $M_\odot$. The number and masses of the largest diffuse nebulae NGC 628 are the same order as in M 33. In the most cases in places of hydrogen emission in H_α line the stellar density is higher than in the neighboring regions. (auth)

6866 THE KINEMATICS OF THE GOULD BELT: AN EXPANDING GROUP. Lesh, Janet Rountree (Univ. of Chicago). Astrophys. J., 17: Suppl. Ser. 151, 371-444(Dec. 1968).

New observational data are presented for 464 stars of Henry Draper type B5 and earlier, $m_v \lesssim 6.5$ and $\delta \gtrsim -20°$, which are likely candidates for membership in a local system defined by the Gould belt. These data include new spectral types on the MK system, classified by the author on Yerkes 40-inch plates; previously unpublished UBV photometry, kindly furnished by Crawford of Kitt Peak; and new proper motions on the system of the FK4, calculated under the author's direction at the Kapteyn Astronomical Laboratory. The observations have been combined to calculate space motions for the 294 program stars having well-determined distances within 600 pc. It is shown that if these stars originated within a small volume of space at some unique time in the past, the present values of the velocity gradients $\partial U/\partial X$, $\partial U/\partial Y$, $\partial V/\partial X$, and $\partial V/\partial Y$ can be used to determine the age of the group. This de-

termination is independent of the location of the Sun, with respect to the center of the group, and of any incompleteness in observation of the group members. However, it is affected by the possible inclusion of non-members in the solution. Least-squares solutions for the velocity gradients have been made for various subsets of the stars with calculated space motions. These solutions provide conclusive evidence for the presence of an expanding element among the nearby B stars but do not yield a unique result for its age. Two models are proposed, one in which the entire sample consists of a mixed population with an over-all expansion age of 90×10^6 years and the other in which the associations constitute an expanding subset aged 45×10^6 years and account for about 30% of the total number of stars. It is shown that either of these models is compatible with the observed gradient perpendicular to the galactic plane and also with a time scale of expansion derived on purely kinematic grounds. (auth)

6867 SPECTROPHOTOMETRIC STUDIES OF EMISSION NEBULOSITIES IN THE MAGELLANIC CLOUDS. I. THE GREAT 30 DORADUS NEBULA. Wares, G. W. (Cerro Tololo Inter-American Observatory, La Serena, Chile); Aller, L. H. Publ. Astron. Soc. Pac., 80: 568-77(Oct. 1968).

Photometrically calibrated spectrograms interpreted with the aid of spectra of standard stars and photoelectric spectrophotometric measurements were used to derive line intensities for emission lines in 30 Doradus. Interpretation of these line intensities by means of conventional theories of nebular line excitation suggests a chemical composition similar to that of matter in our neighborhood in the Galaxy. (auth)

6868 SOME TRENDS IN GALACTIC RESEARCH. Bok, Bart J. (Univ. of Arizona, Tucson). Publ. Astron. Soc. Pac., 80: 501-30(Oct. 1968).

Some of the general trends observed by the author during the past six years are considered. A few topics selected for special attention include: the history of galactic research, overall properties of the Galaxy, gathering of data, calibration problems, models of the Galaxy (the nucleus), and the spiral structure of the Galaxy. (W.D.M.)

6869 FAN BEAM OBSERVATIONS OF BRIGHT GALAXIES AT 408 MHz. Cameron, M. J.; Glanfield, J. R. (Univ. of Sydney). Mon. Notic. Roy. Astron. Soc., 141: 145-64(1968).

The fan beam of the east–west arm of the cross-type radio telescope at the Molonglo Radio Observatory was used to observe 143 galaxies at a frequency of 408 MHz in declination range +18° to/–90°. These form a representative sample of galaxies to a limiting optical magnitude of ~11.0 when corrected for galactic absorption and internal absorption due to the tilt of the emitting galaxy. Of these, 54 were detected down to a limiting flux of 0.4 f.u., at which level the probability of a misidentification is 12%. The galaxies were examined for correlations between radio and optical properties, such as dependence on galaxy type in the Hubble, Morgan (Yerkes), and Van den Bergh (DDO) classification schemes. In the Hubble classification the highest proportion of detected galaxies were of type Sbc and Sc, while only a low proportion of SO/a, Sa, and Sab galaxies were detected. There was a large dispersion in the radio index for a given Hubble type. A correlation was established between the radio index of a galaxy and the degree of central concentration of light in the galaxy, which is the basis of the Morgan classification. Absolute radio magnitudes were determined for the detected galaxies, and it is shown that this absolute radio magnitude correlates with the Van den Bergh galaxy type. (auth) (UK)

Cosmology

6870 COSMOLOGY AND ELECTRODYNAMICS. Hoyle, F.; Narlikar, J. V. (Univ. of Cambridge, Eng.). Nature (London), 220: 893(Nov. 30, 1968).

A reply is made to the criticism by Pegg (Nature, 220: 154 (1968)) of the paper by Hoyle and Narlikar (Nature, 219: 340(1968)) concerning explanation of the spontaneous transition of an atomic electron by the theory of direct interparticle action, and response of the Universe. Pegg argued that Hoyle and Narlikar ignored the role of zero-point oscillations of the electrodynamic field. It is pointed out that the effect to which Pegg refers arises only in the field theory and is entirely absent from the direct particle theory. Differences between the quantum aspects of field theory and the direct particle theory are discussed. (UK)

6871 ENERGY FLUX FROM THE 3^0K RADIATION. Landsberg, P. T.; Johns, K. A. (Univ. Coll., Cardiff, Wales). Nature (London), 220: 1120(Dec. 14, 1968).

A mathematical treatment is presented concerning black-body radiation, isotropic in a frame S_0 which moves with velocity $\underline{v}$ in the observers' frame $\underline{S}$. This is of interest in connection with the problem of measuring the Earth's velocity through the 3°K cosmic background radiation field, and the problem of assigning a temperature to a moving black body. It is noted that a receding source produces an enhanced energy flux and an approaching source a lowered flux, for low frequencies. These effects are qualitatively opposite from those expected from the Doppler effect alone. (UK)

6872 EFFECT OF GRAVITATION ON FREQUENCY. Szekeres, G. (Univ. of New South Wales, Kensington, Australia). Nature (London), 220: 1116-18(Dec. 14, 1968).

Recent observations of the 21-cm absorption line from Taurus A have shown that there is a decrease of frequency, unaccounted for by general relativity, when the optical path approaches the Sun. A frequency decrease has also been observed, roughly proportional to distance, with a terrestrial source (caesium clock). If these observations reveal a genuine effect their significance for unified field theories is of great importance, revealing a serious gap in the Einstein–Riemann model of space–time. The new phenomenon would imply that the phase 4 vector of the beam does not follow the law of Riemann parallel displacement, and is discussed in terms of non-Riemann geometry. The present author had proposed a geometrical field theory based on parallel displacement of spinor type quantities admitting a non-Riemann connection (J. Math. Mech., 6: 471(1957)); predictions of this theory are now compared with experimental evidence. It would appear that the effects are not purely gravitational, but largely of electromagnetic origin. (UK)

Planetary Phenomena

6873 INFRARED COLORIMETRY OF THE MOON. Cruikshank, Dale Paul. Tucson, Ariz., Univ. of Arizona, 1968. 154p. Thesis.

For the purpose of studying the effects of the solar wind flux on the infrared reflectivity properties of rocks and minerals on the Moon, a laboratory apparatus was constructed for irradiation of rock samples with a proton flux having the same energy as the ambient solar wind, but with 10^7 to 10^8 times the flux density. The design and development of the equipment are described. Several volcanic rocks were irradiated with this apparatus and the infrared colorimetric profiles in the wavelength range 0.8 to 2.2 μ were measured for the natural and irradiated samples. Colorimetric observations of small spots (diameter 7 km) on the Moon were made in the spectral region 0.8 to 2.2 μ in an attempt to discern differences from one lunar region to another that would give information on the composition of the surface of the Moon. (Diss. Abstr.) (TSS)

6874 FIFTH SOURCE OF JUPITER DECAMETRIC RADIATION. Wilson, R. G. (Univ. of California, Los Angeles); Warwick, J. W.; Libby, W. F. Nature (London), 220: 1215-18 (Dec. 21, 1968).

A non-Io-controlled "fifth" source of the remarkably intense and variable decametric radiation from a region on or near the visible planetary disk was identified. This non-Io component produces >50% of the decametric emission, and its study is of great potential significance. An investigation is described to separate and characterize both the Io and non-Io-controlled sources. A two-parameter differential spectral analysis of the probability of emission of the decametric radiation was made. With a band width of 2 MHz, maps were prepared for each 2-MHz interval for the range 7 to 40 MHz, the analysis being performed on data from the Boulder radio spectrograph obtained between 1960 and 1966. A distinct area of rather low emission probability was indicated from ~210 to 340° LCM (longitude of central meridian). This "fifth" source was independent of the Io axis, and existed at the effective observational lower limit of 11 MHz up to 28 MHz, where it disappeared completely. Whatever stimulates the planetary mechanism to produce the "fifth" source is probably nonsatellitic in nature, and it is emphasized that this asymmetric source must be considered in any comprehensive theory of decametric radiation. (UK)

6875 EUROPA AND THE DECAMETRIC RADIATION FROM JUPITER. Wilson, R. G. (Univ. of California, Los Angeles); Warwick, J. W.; Dulk, G. A.; Libby, W. F. Nature (London), 220: 1218-22(Dec. 21, 1968).

Plots in the Europa-LCM (longitude of central meridian) domain showed localized areas of enhancement indicating the existence of Europa control of decametric emission. The Europa effect is shown graphically for all frequencies of emission between 7 and 40 MHz, together with modulation by Europa of the Io-controlled sources. Possible mechanisms for Europa control are discussed. The apparent division of Io-controlled emission into double

sources approximately 180° apart on the Europa plot introduces the possibility that Europa control results from some near-resonant condition between the satellites. The recently reported "fifth" source is not Europa-controlled, but is modulated only by Jupiter's rotation. (UK)

Atomic and Molecular Physics

Refer also to abstract 7043.

6876 (IPP-2/68) ON THE INFLUENCE OF LATTICE STRUCTURE AND TEMPERATURE ON THE BACKSCATTERING OF PROTONS FROM COPPER IN THE ENERGY RANGE 40 TO 120 keV. Behrisch, R. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). June 1968. 32p. (In German). Dep.

Thesis. Submitted to Technische Hochschule, Munich, Ger.

The backscattering of protons with energies of 40 to 120 keV from a Cu monocrystal was investigated. The energy and angular distributions were measured with a silicon surface-barrier counter with an energy resolution of 7.5 keV FWHM. Towards low energies the energy distribution of the backscattered protons shows a strong rise. At an angle of incidence of 43° the angular distribution exhibits a maximum for an angle of emergence of 65° if it is measured in a plane not coincident with a shadow direction. Minima are superposed in the close-packed directions. Energy distribution curves calculated from a simple model show a smaller rise towards low energies than the measurements. The region of the shadow minimum in the ⟨100⟩ direction was both recorded with a photographic plate and measured with the counter, and diagrams of lines of equal intensity were drawn. Cross section of the ⟨100⟩ minimum was made parallel to the [210] planes. The minima thus obtained become narrower with increasing ion energy. With rising crystal temperature they change from a box shape to a triangular shape. The exact shapes of the minima agree only approximately with calculated curves. The calculations do not take into account the fact that the ions undergo many angular deflections on passing through the lattice. (tr-auth)

6877 (ORO-2591-38) IONIZATION AND CHARGE TRANSFER CROSS SECTIONS. Progress Report No. 21, December 1, 1967–November 30, 1968. Martin, D. W.; Taylor, G. O. (Georgia Inst. of Tech., Atlanta. School of Physics). Contract AT(40-1)-2591. 18p. Dep. CFSTI.

HELIUM IONS — reactions with helium at 150 to 900 keV, product yields from charge-exchange
— reactions with argon at 0.4 MeV, differential cross sections of charge-exchange
ION BEAMS — reactions with gases, equipment for studies of collision
RECOIL IONS — analyzer system for coincidence studies of ionization and charge transfer collisions (D.L.C.)

6878 AUGER SPECTRA OF URANIUM. Zender, M. J.; Pou, W.; Albridge, R. G. (Vanderbilt Univ., Nashville). Z. Phys., 218: 245-59(1969).

The L, M, and K-Auger and L-Coster-Kronig spectra of uranium were measured and were compared to other experimental and theoretical work. The mean L-shell fluorescence yield of uranium was measured as $\bar{\omega}_L = 0.53 \pm 0.06$. (auth)

6879 SINGLE PARTICLE EXCITATION IN MUONIC ATOMS WITH DEFORMED NUCLEI. Goeke, K. (Univ., Muenster, Ger.); Marschall, H. Z. Phys., 218: 308-18(1969). (In German).

The effect of nuclear rotations and single-particle excitations on the x-ray spectrum of deformed heavy μ-mesic atoms is discussed. The effect is calculated for ^{153}Eu, it is found negligibly small and strongly dependent on the quantum numbers of nuclear single-particle states. A test nucleus is considered with appropriate chosen nuclear states to make predictions on other nuclei. (auth)

6880 ROLE OF LANGMUIR OSCILLATIONS IN THE THEORY OF RESONANCE LUMINESCENCE CAPTURE. Preobrazhenskii, N. G. Opt. Spectrosc. (USSR) (Engl. Transl.), 25: 79-80(July 1968).

Translated from Opt. Spektrosk., 25: 154-5(July 1968).

Skepticism has been expressed (Phys. Rev., 137: 17(1965) and 153: 9(1967)) on the validity of the contemporary theory of radiation capture. An examination is made of the degree to which the skepticism is justified. The occurrence of a phase lead in the resonance radiation from mercury vapor is found to be possible, due to rapid Langmuir processes. Numerical calculation of the effective lifetime of the $3\,^2P$ state in sodium vapor, using kinetic equations, is in full agreement with experiment. It is concluded that the experimental results are entirely explicable within the framework of the contemporary theory of radiation capture. (D.L.C.)

6881 TRANSFER OF EXCITATION FROM THE ^1p TO THE ^1D LEVEL OF HELIUM. Frish, S. E.; Ionikh, Yu. E. Opt. Spectrosc. (USSR) (Engl. Transl.), 25: 91-2(July 1968).

Translated from Opt. Spektrosk., 25: 171-2(July 1968).

The probabilities of excitation transfer from the n ^1P levels to the n ^1D levels in helium for n = 3 and 4 were determined by means of optical pumping in a dc discharge. Two series of experiments were conducted using different filters for the $2\,^1S-3\,^1P$ and $2\,^1S-4\,^1P$ transitions. The cross sections, Q (n $^1P \rightarrow$ n ^1D), were calculated from the data and found to be $2.5 \pm 0.7 \times 10^{-15}$ cm^2 for n = 3 and $8 \pm 3 \times 10^{-15}$ cm^2 for n = 4. Comparisons with data from literature are made. (D.L.C.)

6882 TWO-PHOTON ABSORPTION AND FIELD CORRELATION FUNCTIONS. Mollow, B. R. (Brandeis Univ., Waltham, Mass.). Contract F19628-68-C-0062. Phys. Rev., 175: 1555-63(Nov. 25, 1968).

The probability of an atom undergoing a transition to a given final state by means of two-photon absorption is expressed for arbitrary field states in terms of the second-order normally-ordered field correlation function, evaluated at the position of the atom. In the case of stationary fields, an expression for the absorption rate is found, which reduces to a particularly simple form for narrow-bandwidth fields near resonance. The effect of field statistics is illustrated by comparing the absorption rate $w_2^{(ch)}$ for chaotic or Gaussian light to the rate $w_2^{(l)}$ for laser light. The rate for laser light is calculated within the context of a particular model based on the assumption of fixed field amplitude and random frequency modulation, and the chaotic light to which it is compared is assumed to have the same (Lorentzian) power spectrum. When the width κ_f of the final atomic level is much greater than the bandwidth b of the field, the previously derived result $w_2^{(ch)}/w_2^{(l)} = 2$ is obtained. When $\kappa_f \ll b$, on the other hand, the ratio between the two rates depends on the (mean) frequency of the field, and assumes the (maximum) value 4 when the field is exactly on resonance. (auth)

6883 COHERENT EMISSION OF A PHOTON BY MANY ATOMS. Ernst, V. (Univ., Munich). Z. Phys., 218: 111-28 (1969).

The theory of Weisskopf and Wigner of the natural line width is extended to a case where many atoms at given positions interact with one common quantized radiation field. At time t = 0, one quantum of radiation energy is stored by the atoms, which however does not mean necessarily that exactly one of the atoms must be excited. A study is made of the process of the creation of a photon in dependence on the positions of the atoms and on the state of the system of atoms at t = 0. The dimensions of the emitted wave train and the decay time of this excited atomic state depend sensitively on these parameters. (auth)

6884 EFFECTS OF DETACHMENT AND ION-MOLECULE REACTIONS ON THE DETERMINATION OF IONIZATION AND ATTACHMENT COEFFICIENTS FROM CURRENT-GROWTH EXPERIMENTS. Moruzzi, J. L. (Liverpool Univ.). J. Phys., D (London), 1: 1587-9(Nov. 1968).

In the analysis of current-growth curves for electronegative gases it is important to include ion conversion reactions in the current-growth expression if electron detachment occurs from a particular ion species. This effect is illustrated by examining the current-growth characteristics of oxygen under various conditions. (auth)

6885 TRANSITION FROM THE QUADRATIC TO THE LINEAR STARK EFFECT FOR SPECTRAL LINES OF THE LITHIUM ATOM. CALCULATION OF THE SPLITTING OF ENERGY LEVELS. Elyashevich, M. A.; Tkacheva, V. I. Opt. Spectrosc. (USSR) (Engl. Transl.), 25: 5-7(July 1968).

Translated from Opt. Spektrosk., 25: 12-16(July 1968).

The splitting of the lithium atom energy levels with n = 4, 5, and 6 was calculated with respect to strength of the external electric field, using the perturbation theory method. (auth)

6886 THE CHARACTERISTIC LOSS SPECTRA OF THE SECOND AND THIRD SERIES TRANSITION METALS. Lynch, M. J.; Swan, J. B. (Univ. of Western Australia, Nedlands). Aust. J. Phys., 21: 811-16(Dec. 1968).

Characteristic electron energy loss spectra are presented for the second and third series transition metals Y, Zr, Nb, Mo, Rh, Pd, Ag, and Hf, Ta, W, Re, Ir, Pt, Au. An identification of most of the spectral features in terms of collective and individual particle excitations is made. (auth)

6887 EXCITATION OF MOLECULAR OXYGEN BY LOW-ENERGY ELECTRONS. Skubenich, V. V. Opt. Spectrosc. (USSR) (Engl. Transl.), 25: 90-1(July 1968).

Translated from Opt. Spektrosk., 25: 169-70(July 1968).

Lanthanum boride cathodes were used in measurements of the absolute excitation cross sections of the $b^4\Sigma_g^-$ and $A^2\Pi_u$ states of O_2^+ molecules. The cross sections are plotted versus energy over the range 10 to 160 eV. (D.L.C.)

6888 ENERGY TRANSFER IN MOLECULAR COLLISIONS. Riley, Merle Eugene. Pasadena, Calif., California Inst. of Tech., 1968. 287p.

Thesis.

Two general, numerically exact, quantum-mechanical methods have been developed for the calculation of energy transfer in molecular collisions. The methods do not treat electronic transitions because of the exchange symmetry of the electrons. All interactions between the atoms in the system are written as potential energies. The first method is a matrix generalization of the invariant imbedding procedure, adapted for multi-channel collision processes. The second method is based on a direct integration of the matrix Schrödinger equation, with a re-orthogonalization transform applied during the integration. Both methods have been applied to a collinear collision model for two diatoms, interacting via a repulsive exponential potential. Two major studies were performed. The first was to determine the energy dependence of the transition probabilities for an H_2 on H_2 model system. Transitions are possible between translational energy and vibrational energy, and from vibrational modes of one H_2 to the other H_2. The second study was to determine the variation of vibrational energy transfer probability with differences in natural frequency of two diatoms similar to N_2. Comparisons were made to previous approximate analytical solutions of this same problem. For translational to vibrational energy transfer, the previous approximations were not adequate. For vibrational to vibrational energy transfer of one vibrational quantum, the approximations were quite good. (Disser. Abstr.)

6889 SUB-CONFIGURATIONS $4f^66s6p$ AND $4f^55d6s^2$ OF Sm I. Carlier, Annik; Blaise, Jean; Schweighofer, Marie-Gabrielle (CNRS, Orsay, France). J. Phys. (Paris), 29: 729-38(Aug.-Sept. 1968). (In French).

A number of levels of Sm I have been identified with the help of their isotope shift and Landé g factor. The theoretical calculation of the energy eigenvalues and the Landé g factors of the levels of the sub-configurations $4f^6(^7F)6s6p + 4f^5(^6H-{}^6F)5d6s^2$ taken together, has allowed the interpretation of 127 observed levels with a r.m.s. error of 105 K. The eigenvectors, given in the LS coupling, show the mixture of $4f^66s6p$ and $4f^55d6s^2$ beginning at 18,000 K. The values of the parameters of electrostatic and spin-orbit interaction were fitted by the least-squares method. (auth)

6890 CHARGE EXCHANGE COLLISIONS INVOLVING MULTIELECTRON ATOMS (LITHIUM AND SODIUM). Lodge, J. G.; May, R. M. (Univ. of Sydney). Aust. J. Phys., 21: 793-801(Dec. 1968).

The cross section for forming both ground-state and excited-state hydrogen atoms by charge exchange between protons and lithium or sodium atoms was calculated. These calculations were performed using the Brinkman–Kramers approximation along with a multiplicative correction factor; the target lithium and sodium atoms are first described by simple "effective-Z" wave functions, and then the lithium case is treated more accurately both by including the inner electrons and by using a more accurate numerical lithium wave function. The results are in satisfactory agreement with the experiments of Il'in et al. Both theory and experiment pertain to incident proton energies of around 10 to 100 keV. (auth)

6891 COLLISION-INDUCED DISSOCIATION OF LOW-KINETIC-ENERGY IONS. Moran, T. F. (Georgia Inst. of Tech., Atlanta); Roberts, J. R. J. Chem. Phys., 49: 3411-21(Oct. 15, 1968).

Dissociative reactions of H_2^+, O_2^+, and NO^+ molecular ions with various atoms and molecules have been measured for reactant ions having kinetic energies less than 50 eV. Initial velocity components of the reactant ions in these experiments are axial to the slit system of the analyzing mass spectrometer, which serves to discriminate against charged reactants but allows for effective collection of the slow reaction products. The cross sections for the production of low-kinetic energy H^+, N^+, and O^+ ions range from 0.01 to 1.0 $Å^2$ near threshold. Reasonably sharp kinetic-energy thresholds for atomic-ion formation measured in these experiments approximate known molecule–ion dissociation energies. (auth)

6892 SELECTED TOPICS IN THE THEORY OF ATOMIC SPECTRA. Odabasi, Halis. Boulder, Colo., Univ. of Colorado, 1968. 574p.

Thesis.

A brief background in time-independent perturbation theory, quantum theory of complex atoms, line strength, and variation principle is introduced. The numerical procedure is outlined. The theoretical ionization potentials, term and level energies in SLJM and intermediate coupling scheme, for the five lowest lying configurations of Silicon, Phosphorus, and Sulfur isoelectronic sequences are calculated by using nonrelativistic Hartree–Fock–Slater basis sets. In the process of evaluation, different interactions are added one at a time to give an idea about their effects. At each step, the theoretical results are compared with the observed ones. To exhibit the mixing of terms or levels for typical cases, the "mixing coefficients," as defined in the text, are tabulated. In the Beryllium isoelectronic sequence, with the exception of Be I and B II, the observations show that the $2s3p\ ^3P$ term lies higher than the $2s3p\ ^1P$ term, contrary to the theoretical expectation. The fact is explained by configuration mixing. Other configuration mixing calculations are carried out for the $3p4p\ ^3D$, ^3P, ^3S, ^1D, ^1P, and ^1S terms in the Silicon isoelectronic sequence. The behavior of line strengths in the extreme mixing of the levels due to spin-orbit interaction is shown by calculating intermediate coupling line strengths for 3s–3p and 3p–3d transitions in the Carbon isoelectronic sequence. (Disser. Abstr.)

6893 CALCULATIONS OF INELASTIC CROSS SECTIONS FOR ROTATIONAL EXCITATION. II. RESONANCES IN THE ELASTIC CROSS SECTION OF N_2 (j = 0) MOLECULES AT ENERGIES BELOW THE THRESHOLD FOR ROTATIONAL EXCITATION. von Seggern, M.; Toennies, J. P. (Univ., Bonn). Z. Phys., 218: 341-51(1969).

Cross sections for scattering of N_2 (j = 0) molecules on He atoms are calculated for relative energies below the excitation threshold for the N_2 (j = 2) rotational state. The close coupling method is used and the coupled differential equations are solved numerically. Very sharp resonances (corresponding to a lifetime of 10^{-10} sec) caused by quasi-stable states of the N_2He system are found in the calculated cross section, when the closed channels corresponding to the N_2 (j = 2) states are included in the coupled equations. The position of the resonances is compared with the calculated energy eigenvalues of the corresponding two-body potential. Furthermore, the equilibrium concentration of the N_2He quasi-stable and orbiting states is calculated at 80°K and p_{N_2} = 1 atm. Both concentrations are found to be 1%. (auth)

6894 PRINCIPLES OF ATOMIC ORBITALS. (Revised Edition). Greenwood, N. N. London, Royal Institute of Chemistry, 1968. 52p. 8s 2d.

The subject is discussed under the following headings: Introduction; the hydrogen atom; many-electron atoms; and the periodic classification. (UK)

6895 OSCILLATOR STRENGTHS FOR ELECTRIC DIPOLE TRANSITIONS OF HYDROGEN. Goldwire, Henry C. Jr. (Rice Univ., Houston, Tex. California Inst. of Tech., Pasadena). Astrophys. J., 17: Suppl. Ser. 152, 445-66(Dec. 1968).

Expressions which are especially suited for machine evaluation were derived for the radial matrix integrals for electric dipole transitions between hydrogenic eigenstates. Total absorption oscillator strengths for permitted transitions from the states of a given principal quantum number n′ to those of n are tabulated both for all $n' < n \leq 50$ and for all $n \leq 500$ where $n - n' \leq 5$. The methods and the accuracy of the calculations are discussed. (auth)

Cosmic Radiation

Refer also to abstracts 6284 and 6871.

6896 (AECL-3161) COSMIC RAY NM-64 NEUTRON MONITOR DATA. X. Monthly Graphs, May–August 1968. Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Sept. 1968. 75p. Dep. CFSTI. CAN $2.00.

Uncorrected and barometer-corrected results from the cosmic-ray stations in Canada using equipment maintained by AECL are given in tabular form for the period from May to August, 1968. Normalized graphs are given for the same period. (auth)

6897 UPPER LIMITS ON LOW-ENERGY COSMIC-RAY PROTONS AND HEAVY NUCLEI IN INTERSTELLAR SPACE. Apparao, M. V. K. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Nature (London), 220: 1015-16(Dec. 7, 1968).

Observations on extraterrestrial background gamma radiation

between 0.3 and 2 MeV are employed to set upper limits for cosmic-ray protons and CNO nuclei in interstellar space, and the values obtained are used to indicate the nature of solar modulation at low energies. The methods of production of gamma rays in interstellar space are enumerated; the nucleon–nucleus reaction through nuclear de-excitation is employed to determine the upper limits, assuming that all the gamma radiation between 0.5 and 2 MeV arises from this process. Values obtained are 1.43 $cm^{-2}sr^{-1}s^{-1}$ for the flux of CNO nuclei and 1,100 $cm^{-2}sr^{-1}s^{-1}$ for the flux of protons. For determination of modulation factors (ratio of intensity in interstellar space to that at the Earth) an anisotropic solar modulation model is used in which the low-energy particles leak into the solar magnetosphere from high latitudes; results are tabulated, and compared with those from other models. (UK)

6898 ON THE RELATIONSHIP BETWEEN RECENT MEASUREMENTS OF COSMIC RAY ELECTRONS, NONTHERMAL RADIO EMISSION FROM THE GALAXY, AND THE SOLAR MODULATION OF COSMIC RAYS. Webber, W. R. (Univ. of Minnesota, Minneapolis). Aust. J. Phys., 21: 845-70(Dec. 1968).

Utilizing recent measurements of the cosmic-ray electron spectrum at the Earth and the effects of solar modulation on this spectrum, possible limits on the local interstellar electron spectrum were determined. Synchrotron emission from these interstellar electrons was then compared with the local (disk) volume emissivity of nonthermal radio emission as deduced from a study of radio intensity profiles along the galactic equator. The detailed spectrum and magnitude of radio emissivity can be reproduced from the electron spectrum only for very stringent conditions on the magnitude of the local interstellar magnetic field, and the amount of solar modulation of cosmic rays. Specifically it was found that $B_\perp \approx 7\ \mu G$, and the residual modulation parameter $K_R \approx 0.75$ GV. If solar modulation effects on the cosmic-ray electron component are negligible, then an implausibly high local field of $\approx 20\ \mu G$ is required. If the local interstellar electron spectrum that best reproduces the spectrum of local radio emissivity is compared with the electrons expected as secondaries from cosmic-ray collisions in the Galaxy, it is found that most electrons $\lesssim 300$ MeV may originate via the secondary mechanism rather than be directly accelerated as are the higher energy electrons. Adaption of this local interstellar electron spectrum which is quite different from that at the Earth also greatly modifies the interpretation of the effects of interstellar absorption by ionized hydrogen on the low-frequency end of the radio spectrum. Emission measures of <0.5, 20, and 10^3 cm^{-6} pc are found in the polar, anticenter, and galactic center directions, respectively. These values are substantially below earlier estimates and would seem to rule out the existence of a large H II region about the Sun, for example. Finally, it is noted that the interstellar intensity of cosmic-ray nuclei above 30 MeV, deduced by means of a residual modulation constant of 0.75 GV is inadequate by two orders of magnitude to produce the required heating of interstellar H II clouds. If this heating is produced by cosmic rays it must be caused by a low-energy component with a very steep spectrum. It is argued that such a component might arise from cosmic-ray emission from solar-type stars in the Galaxy. (auth)

6899 VERY HEAVY NUCLEI IN COSMIC RAYS. Apparao, Krishna M. V. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Sky. Telesc., 37: 23-4(Jan. 1969).

The origin of the primary cosmic-ray particles is considered. The significance of very heavy nuclei in cosmic rays for the content of interstellar space and for the origin of cosmic rays is discussed. (W.D.M.)

6900 SOME RESULTS OF INVESTIGATIONS OF DIURNAL VARIATION IN NUCLEON AND HARD COMPONENTS OF COSMIC RAYS. Pankratov, A. K.; Stepanyan, A. A. Izv. Krym. Astrofiz. Observ., 38: 120-31(1967)(Publ. 1968). (In Russian).

Uninterrupted values of the amplitude and phase of diurnal variation in the meson component of cosmic rays were obtained. These values are found to be more changeable than ones in neutron component. The most probable value of the amplitude is 0.30%, and of phase—240°. The division of diurnal variation into two components, stationary and nonstationary, was carried out. The mean characteristics of both components were estimated. It is shown that "phase jumps" and "phase rotation" in diurnal variation, connected with a sharp vector change of nonstationary diurnal variation, correlate with changes in K_p. It is shown that "phase jumps" apparently take place when the Earth crosses the sector boundary of the interplanetary magnetic field. The direction of the nonstationary component is closely connected in this case with the velocity change of the solar wind (more exact, the ratio of wind velocity to the diffusion coefficient of cosmic rays). It was found that large amplitudes in diurnal variation appear, mainly, when the amplitude of the nonstationary component is large, and it direction coincides with that one of the stationary component of diurnal variation. (auth)

6901 INTENSITY AND ANGULAR DISTRIBUTION OF MUONS UNDER GROUND. Kotov, Yu. D.; Logunov, V. M. (Moscow Engineering-Physics Inst.). Yadern. Fiz., 8: 750-8(Oct. 1968). (In Russian).

Calculations of the muon range in the medium with Z = 10, 11, 12, 13 and of the angular distribution of muons under ground are presented. Based on the muon energy spectrum and on the energy–range dependence, the curves of the muon absorption are obtained. The effect of fluctuations is estimated, and the results obtained are compared with the experimental data and with the results of other authors. (auth)

Direct Energy Conversion

Refer also to abstracts 6235 and 6860.

6902 (NP–17700) THERMIONIC RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report No. 1. Jacobson, D. L.; Hamerdinger, R.; Campbell, A. (Electro-Optical Systems, Inc., Pasadena, Calif.). Oct. 12, 1968. Contract 952217. 51p. (EOS–4006-Q-2).

An investigation was made of single-crystal rhenium electrodes or other refractory materials for the purpose of yielding a low-work-function collector surface. Specific investigations include vacuum emission vehicle determination of the effective and Richardson work functions, as well as qualitative and quantitative examination of electrode surfaces using a thermionic emission microscope. Metallurgical examinations include x-ray diffraction and metallographic and spectrographic analyses. These same electrodes will then be investigated in a variable parameter test vehicle for minimum work function and optimized power output. Based upon variable parameter test vehicle data, a planar converter will be fabricated and tested for the purpose of comparing test vehicle to converter performance. An investigation was also made of vapor-deposited W–20% Re electrodes utilizing vacuum emission, electron emission microscope, and variable parameter vehicle evaluations with, however, the subsequent fabrication and testing of two planar converters. The program effort was completed on the design, fabrication, and test of cylindrical thermionic converters for the principal purpose of providing a direct performance comparison between planar and cylindrical converters. The cylindrical converter design is adaptable to radioisotopic and out-of-file thermionic systems. Basically, the design allows the individual converter to be mounted on a sapphire-insulated heat pipe emanating from a common heat source to form an array of converters that can be externally connected for series–parallel choice hookup. Moreover, each converter contains a separate reservoir which allows for individual converter testing and optimization. An array of five converters could yield an estimated electrical output of 100 watts at 2.0 volts; ten such arrays could yield an unconditioned electrical power output of 1 kilowatt. (auth)

6903 LIQUID METAL MAGNETOHYDRODYNAMIC POWER GENERATOR. Chandrasekhara, B. C.; Kuchela, K. N.; Rudraiah, N. (Bangalore Univ., India). Curr. Sci. (India), 37: 688-9 (Dec. 20, 1968).

The theory of a MHD generator using a heterogeneous conducting fluid in a rectangular channel is studied. Equations are derived for the potential and current. For infinite channel length, the efficiency of the generator is $\epsilon_g = (2\phi_w)/(UBh)\ \sqrt{(\rho)}/(\rho_0)$, where ϕ_w = potential, U = free upstream velocity, ρ = variable density, and ρ_0 = reference density. It is concluded that the use of a heterogeneous fluid increases the power output and efficiency. (D.L.C.)

6904 REFLECTIONS OF ELECTRON BEAMS IN THERMIONIC DIODES. Morris, James F. (Lewis Research Center, Cleveland). J. Appl. Phys., 39: 6099-6100(Dec. 1968).

Some backscattering occurs in the acceleration of electrons from an emitter through a positive-ion sheath into a plasma. Plasma collisional effects on positive-ion sheaths at emitters and on net currents in cesium diodes are discussed. The kinetic reflection coefficients proposed by Baksht, et al., are used, and low-ionization near-equilibrium conditions are evaluated. Equations are derived for the density of the emitted and reflected electron beams. The effects of the electron number densities on sheath charge densities and voltages are shown to be small, even for the nonequilibrium case. Some calculations are given for the effects on transmitted currents for a positive-ion sheath drop of 1 V and a temperature of 2000°K. It is concluded that kinetic reflections affect sheath structures and transport only trivially in cesium di-

odes, and that calculations require no corrections for plasma scattering of emitted electron beams. (D.L.C.)

6905 MAGNETO-HYDRO-DYNAMIC OR MAGNETO-GAS-DYNAMIC DEVICES. Weh, Herbert. British Patent 1,134,208. Nov. 20, 1968. Priority date Feb. 3, 1965, Germany.

The MHD or MGD device described comprises a duct section through which a liquid or gaseous electrically conducting medium is caused to flow. Blocks of laminations are in contact with two opposite sides of the duct section. The blocks are provided with slots for a winding to produce a magnetic field traveling in the direction of the duct's axis. Side bars are arranged in contact with the duct at opposite regions between the winding-carrying blocks. These side bars consist of conducting material to close the paths for the current passing through the flowing working medium at right angles to the direction of the medium flow. The bars are composed of component conductors in the form of a stack of laminations insulated from one another, each lamination having its longitudinal direction substantially parallel to the axis of the duct. (M.H.R.)

6906 RADIAL ELECTRIC FIELD PARAMETER IN EHD POWER GENERATORS WITH SEGMENTED-ELECTRODES. Kaneda, Katsuichi (Resources Research Inst., Kawaguchi, Japan). Jap. J. Appl. Phys., 8: 125-6(1969).

The contribution of the radial electric field to the EHD generator performance is considered. In opposition to the parameter α in Brandmaier's analysis, a new radial field parameter ϵ_r is proposed, and equations are derived. From the experimental potential distribution, and neglecting the charged-particle drift velocity, it is shown that ϵ_r may be determined by the nondimensional parameters α, β, and S_0 at the conversion channel inlet. (D.L.C.)

Fluid Physics

6907 UNSTEADY COUETTE FLOW OF A CONDUCTING FLUID BETWEEN TWO PARALLEL PLATES UNDER A TRANSVERSE MAGNETIC FIELD. II. Vidyanidhi, V. (Andhra Univ., Waltair, India). Proc. Indian Acad. Sci., Sect. A, 68: 93-102 (Aug. 1968).

The effect of a sudden change in magnetic field and pressure gradient on a steady Couette flow of a viscous incompressible fluid between two parallel plates in the presence of a transverse magnetic field is considered. Expressions for the velocity of the fluid in the disturbed flow, and for the intensities of the electric and magnetic fields, are obtained in two cases: when the plates are non-conducting and when they are perfectly conducting. (auth)

6908 EFFECT OF HORIZONTAL AND VERTICAL MAGNETIC FIELDS ON KELVIN–HELMHOLTZ INSTABILITY. Sharma, R. C.; Srivastava, K. M. (Univ. of Jodhpur, India). Aust. J. Phys., 21: 917-21(Dec. 1968).

This paper discusses the effect of a general oblique magnetic field on the stability of two superposed fluids in relative horizontal motion. The stable and unstable cases at the interface (z = 0) between two uniform fluids with constant densities and velocities of streaming are separately discussed. The combined effect of horizontal and vertical magnetic fields is to increase the wavelength at which the Kelvin–Helmholtz instability sets in. (auth)

6909 EFFECT OF HORIZONTAL AND VERTICAL MAGNETIC FIELDS ON RAYLEIGH–TAYLOR INSTABILITY. Sharma, R. C.; Srivastava, K. M. (Univ. of Jodhpur, India). Aust. J. Phys., 21: 923-9(Dec. 1968).

A general equation studying the combined effect of horizontal and vertical magnetic fields on the stability of two superposed fluids was obtained. The unstable and stable cases at the interface (z = 0) between two uniform fluids, with both the possibilities of real and complex n, were separately dealt with. Some new results were obtained. In the unstable case with real n, the perturbations are damped or unstable according as $2(k^2 - k_x^2L^2) - (\alpha_2 - \alpha_1)k$ is > or < 0. In the stable case, the perturbations are stable or unstable according as $2(k^2 - k_x^2L^2) + (\alpha_1 - \alpha_2)k$ is > or < 0. The perturbations become unstable if $H_{||}/H_{\perp}$ (= L) is large. Both the cases are also discussed with imaginary n. (auth)

6910 STUDY OF COMBINED EFFECT OF KELVIN–HELMHOLTZ INSTABILITY AND GRAVITATIONAL INSTABILITY ON A SELF-GRAVITATING FLUID LAYER. Uberoi, C.; Isaac, R. Jayakaran (Indian Inst. of Science, Bangalore). Aust. J. Phys., 21: 931-7(Dec. 1968).

The instability of a self-gravitating fluid layer of finite thickness surrounded by another fluid of different density was studied recently by Uberoi (1963) and Tassoul (1967) under varying conditions. The above instability can occur when the fluid layer and the surrounding material are in relative horizontal motion. An attempt is made to study the combined effects of the Kelvin–Helmholtz instability associated with short wavelengths and the gravitational instability associated with long wavelengths on this layer. (W.D.M.)

6911 HYDROMAGNETIC FLOW IN A ROTATING STRAIGHT PIPE. Vidyanidhi, V.; Rao, V. V. Ramana (Andhra Univ., Waltair, India). J. Phys. Soc. Jap., 25: 1694-1700(Dec. 1968).

A theoretical analysis is made of the flow of a conducting viscous and incompressible fluid through a straight pipe of circular cross section flowing under a constant pressure gradient. The pipe is rotated about an axis perpendicular to it and also there is imposed a uniform magnetic field transverse to the motion. It is assumed, for the purpose of mathematical analysis, that the angular velocity about the axis of rotation is small. A solution is developed by successive approximations in ascending powers of the Hartmann number, the first approximation corresponding to the nonmagnetic case, formulated and discussed by Barua. The streamlines in the central plane and the projection of the streamlines on the cross section of the pipe are compared with those in the nonmagnetic case. An expression for the induced electric potential difference and sensitivity was obtained. (auth)

6912 PLANE PARALLEL FLOW OF A CONDUCTING DUSTY GAS. Baral, M. C. (Tripura Engineering Coll., India). J. Phys. Soc. Jap., 25: 1701-2(Dec. 1968).

The problem of flow of a conducting dusty gas occupying a semi-infinite space in the presence of a transverse magnetic field is solved. (auth)

6913 MAGNETOHYDRODYNAMIC ALIGNED FLOW OF A COMPRESSIBLE FLUID PAST A SLENDER BODY PLACED IN A CIRCULAR WIND TUNNEL. Kusukawa, Ken-ichi (Tokyo Metropolitan Univ.); Suwa, Shigeaki. J. Phys. Soc. Jap., 25: 1703-22(Dec. 1968).

The steady flow of a compressible electrically conducting fluid past a slender body of arbitrary cross section placed in a circular wind tunnel, in the presence of an applied aligned magnetic field, is dealt with by the slender-body approximation. The wind tunnel interference always appears even if the flow is supersonic, contrasted with the conventional nonconducting flow. For an example, the velocity and the electromagnetic fields in the flow past a body of revolution at a small incidence are calculated. The drag and the lift of the body are evaluated, and the effect of wind tunnel causing some changes in their values is studied. (auth)

Geophysics

6914 VARIATIONS OF AURORAL EMISSIONS WITH TIME, MAGNETIC ACTIVITY, AND THE SOLAR CYCLE. Sandford, P. B. (DSIR, Lower Hutt, New Zealand). J. Atmos. Terrest. Phys., 30: 1921-42(Dec. 1968).

The diurnal, magnetic, and solar cycle dependence of discrete auroral occurrences and intensities of emissions at 3914, 5577, and 6300 Å over Antarctica in 1959 and 1963 is discussed and illustrated with maps of average intensities for latitudes greater than 50°. Two types of discrete visual aurora are described: the night-peak discrete aurora, closely associated with polar magnetic substorms and showing positional but little intensity change with the solar cycle; and the day-peak discrete aurora, a weak rayed form in the morning in quiet conditions. Nonvisual emissions of importance are: the mantle aurora, which is closely associated with the polar magnetic substorm and is the main source of auroral emission at solar maximum, but becomes of less importance at solar minimum; and the 6300-Å emission which has a polar-cap enhancement that was pronounced in 1959 but only weakly evident in 1963. (auth) (UK)

6915 MAGNETOPAUSE SURFACES AND FIELDS FOR VARIOUS INCLINATIONS OF THE EARTH'S DIPOLE AXIS TO THE SOLAR WIND. Olson, Willard Paul. Los Angeles, Univ. of California, 1968. 113p.

Thesis.

The interaction of the solar wind with the Earth's magnetic field is studied. A model for the determination of the shape of the magnetopause is developed which allows the inclusion of cases where the wind is directed obliquely toward the geomagnetic dipole axis. The variation in the shape of the surface with time is then examined. Particular attention is paid to the currents flowing on the magnetopause surface and the magnetic fields they produce in the vicinity of the Earth. It is found that the magnetic field at the Earth's surface produced by this model accounts for a considerable portion of the observed annual and semiannual variations. The diurnal variations from these currents, although large, are unlike the observed S_q variations and must be masked by the magnetic

fields produced by currents originating in the ionosphere. The magnetic field variations produced by this model at geosynchronous altitude are also studied and are shown to be similar to those observed by ATS-I. The solar wind is assumed to have no motions perpendicular to its (constant) velocity vector (zero temperature) and to be free from all magnetic fields. The Earth's magnetic field is represented by a centric dipole. Essentially, the magnetopause surfaces are computed by the self-consistent field method of Mead and Beard. (Diss. Abstr.)

6916 THE PROPAGATION CHARACTERISTICS OF ELF RADIO WAVES TO GREAT DISTANCES BELOW THE HORIZONTALLY STRATIFIED IONOSPHERE. Yamashita, Michiko (Nagoya Univ., Toyokawa, Japan). J. Atmos. Terrest. Phys., 30: 1943-53(Dec. 1968).

The wavelength of the elf radio waves is so long (1 Hz to 3 kHz) that they can penetrate deeper into the ionosphere than the vlf. Assuming a two-layered model of the ionosphere, the characteristics are derived in order to obtain the attenuation coefficients of the waves. It is shown that the results agree with the solution using Wait's (1962) modal equation. An explanation of the SEA phenomena on elf atmospherics is also given. It is found that the two-layered model is suitable for interpreting the SEA phenomena, while the single-layer (homogeneous) model is not. Hence it is necessary to use the two-layered model in the treatment of elf propagation. (auth) (UK)

6917 ELECTRON AND POSITIVE ION DENSITY MEASUREMENTS DURING CONDITIONS OF AURORAL ABSORPTION. Jespersen, M.; Kane, J. A.; Landmark, B. (Danish Space Research Inst., Copenhagen). J. Atmos. Terrest. Phys., 30: 1955-63(Dec. 1968).

From a rocket fired into a nighttime auroral absorption event simultaneous measurements were made of the positive ion density, N_+, and the density of free electrons, N. The results show a decreasing ratio of N/N_+ with decreasing altitude. A number of electron density profiles were obtained during similar conditions, but without positive ion measurements. These profiles were analyzed, and it is shown that at the lower levels of the D region more free electrons are present during the day than during the night. The results are consistent in showing that negative ions must be an important constituent of the nighttime D region. (auth) (UK)

6918 FRICTIONAL FORCES AND COLLISION FREQUENCIES BETWEEN MOVING ION AND NEUTRAL GASES. Stubbe, Peter (Goddard Space Flight Center, Greenbelt, Md.). J. Atmos. Terrest. Phys., 30: 1965-85(Dec. 1968).

Two different terms are used in the literature for the frictional force between moving ion and neutral gases. It is shown how the corresponding collision frequencies must be defined in order to keep both terms valid. An expression is derived for the momentum transfer collision frequency ν_{in} between ions and neutral particles as a function of temperature and the relative flow velocity $|v_i - v_n|$. The result indicates that for most practical applications ν_{in} may be considered as independent of $|v_i - v_n|$. However, for very high velocities, e.g., a convection flow from the magnetosphere into the ionosphere, there may be a significant dependence. Numerical values for ν_{in} are presented. In the case of collisions between ions and their parent neutral gases, laboratory values are used for the resonant charge exchange cross section for high energies, but a correction is made for the much smaller thermal energies in the temperature range typical for ionospheric conditions in order to take into account the effect of curved particle trajectories due to attractive electrostatic forces. (auth) (UK)

6919 VARIABILITY OF TIME SHIFTS IN THE SPACED FADING RECORDS. Reddi, C. Raghava; Rao, B. Ramachandra (Andhra Univ., Waltair, India). J. Atmos. Terrest. Phys., 30: 1987-94(Dec. 1968).

The variations in phase path recorded at three closely spaced points can be used for measuring horizontal drifts at the E-region level. The variability of time shifts in spaced fading records was investigated, using simultaneous spaced phase path and fading records. The observed variability in time shifts can be interpreted as due to continuous changes in the direction of arrival, and interference between more than one signal. Portions of the spaced phase path records influenced by changes in the direction of arrival and interference effects can be easily identified, and reliable horizontal drift measurements can be made from the phase path records that are not contaminated by the above two effects. No such identification is possible in the spaced fading records. (auth) (UK)

6920 HORIZONTAL DRIFTS AT THE E-REGION LEVEL BY THE SPACED PHASE PATH TECHNIQUE. Reddi, C. Raghava; Rao, B. Ramachandra (Andhra Univ., Waltair, India). J. Atmos. Terrest. Phys., 30: 1995-8(Dec. 1968).

The results of a study of horizontal drifts at the E-region level measured at Waltair during the period November 1965 through October 1966 by the spaced phase path technique are presented. (auth) (UK)

6921 ABSOLUTE TRANSITION PROBABILITY OF THE AURORAL GREEN LINE. McConkey, J. W.; Kernahan, J. A. (Queen's Univ., Belfast). Nature (London), 220: 1017-18(Dec. 7, 1968).

A measurement of the transition probability of the 5577 Å ($^1S_0 - {}^1D_2$) oxygen auroral line is important since this is one of the predominant spectral features of aurorae and the upper atmosphere, and also to provide a check on theoretical predictions, taking into account the quadrupole nature of the transition. A preliminary report on measurement of the absolute transmission probability of this multipole line is presented. The line was strongly excited by passing a 50-Hz, 100-mA high-voltage discharge through a mixture of O_2 and He at 20 mm Hg. The O_2 content of the mixture was ~0.5%. The value obtained was $1.3 \pm 0.4 s^{-1}$, agreeing with the theoretical value of $1.28 s^{-1}$ (Garstang, Mon. Not. Roy. Astro. Soc., 111: 115(1951)). (UK)

6922 ELECTROMAGNETIC WAVE SCATTERING BY CYLINDRICAL IRREGULARITIES IN IONOSPHERIC PLASMA. Hayakawa, Masashi; Ohtsu, Jinsuke (Nagoya Univ., Japan). Kakuyugo-Kenkyu, 21: 366-76(Nov. 1968). (In Japanese).

The scattering of oblique-incidence electromagnetic waves by a cylindrically inhomogeneous irregularity in an unmagnetized plasma was investigated. This problem is very important in radio-wave propagation in the ionosphere. The cylindrical irregularity, whose radial density distribution is assumed to be of parabolic form, is imbedded in a homogeneous plasma. Under this condition, analytical expressions of scattered wave fields produced by radio waves at any angle with the irregularity are discussed. Also, the wave field distributions inside the irregularity are fully given. Formulas of scattering patterns are given analytically as functions of frequency, incidence angle, and irregularity width. As special cases, the scattering by a magnetic field-aligned irregularity at normal incidence and by irregularities with regular spatial distribution is also discussed. (NSA of Japan)

6923 THE TEMPERATURE AT 120 KM ALTITUDE IN APRIL–MAY 1965. Sheppard, L. M. (Australian Defence Scientific Service, Salisbury). Aust. J. Phys., 21: 939-40(Dec. 1968).

New data are given on the variability of temperature near 120 km using results obtained from observations of 10 grenade glow clouds between 118 and 174 km. Molecular diffusion coefficients were calculated and the atmospheric temperature and density determined, using the methods described by Lloyd and Sheppard (1966). (W.D.M.)

6924 STATISTICAL INVESTIGATION ON POLAR AURORAS. Giorgi, Maurizio; Gregori, Giovanni P.; Valenti, Carlo (CENFAM, Rome). Pure Appl. Geophys., 71: 42-50(1968/III).

The magnetosphere depends on the astronomical orientation of the geomagnetic field with respect to the solar wind. The statistical distribution of polar auroras must therefore depend on the orientation of the geomagnetic field with respect to the ecliptic plane. This peculiar feature of auroras that is called auroral astronomical geometry was investigated. Some preliminary results concerning a limited set of pre-IGY auroras are given. The criteria chosen to prepare the auroral collection are also briefly summarized. The results conform to the hypothesis of the auroral origin from the magnetospheric neutral sheet. Auroral particles are found to impinge over the Earth with low angles with respect to the ecliptic plane ($\leq 40°$). Only in a 4-hour interval around midnight they are found to impinge with angles up to 70°. Definite evidence of these facts requires further investigation with a larger amount of data. A complex code for recording the morphological features of each aurora was prepared, namely: standard information, movement, intensity, color, sunlight illumination, period of pulsation, location in the sky among stars and planets, time evolution, duration, and general features of the auroral display. It is well known in fact that the auroral morphology affects auroral heights and latitudes, etc.; presumably it should also affect its astronomical geometry. (auth)

6925 ON THE ELECTROJET IN SOUTH AMERICA. Affolter, Hugo R. (National Univ. of La Plata). Pure Appl. Geophys., 71: 37-41(1968/III).

The diurnal variation in the horizontal component (H) of South American stations under and close to the electrojet were plotted during the IGY. Thus a dilatation towards the south of the electrojet in the western part of South America was inferred. (auth)

6926 NARROWING OF THE IONOSPHERIC ABSORPTION ANOMALY BY SOLAR ECLIPSES. Nestorov, Georgi. T. (Geophysical Inst., Sofia). Pure Appl. Geophys., 71: 26-36(1968/III).

One of the most interesting effects in the D region due to solar eclipses is the narrowing of the absorption anomaly on observing the long and middle waves. The theoretical analysis carried out by means of the continuity equation shows that the observed effects are due to the versatile behavior of the equation terms and most of all to the ratios of the negative ions to electrons λ. In the course of the eclipse, λ increases which has as a consequence a whole series of quantitative and qualitative variations in the absorbing plasma of the D region. The frequency dependence of the narrowing effect is due to the different height of reflection of the long (0.1 Mc) and middle (1 Mc) waves. The link of the magnitude of the anomaly with the solar zenith angle is a result of the complex mutual dependency between the change velocity of the electrons and negative ions as well as of the opposite or simultaneous change of the solar zenith angle and the visibility of the solar disc. The near coincidence of the theory with experiment confirms the validity of the initial equations for the ratios of the negative ions to electrons, for the coefficient of dissociative recombination and for the lower boundary of the D region. The idea of the immediate recovering of quasi equilibrium for negative ions after sunrise is not real. In the course of an eclipse quasi equilibrium is lacking both for negative ions and electrons. (auth)

6927 DISSOCIATIVE VELOCITY RATES OF OXYGEN AND OZONE IN THE IONOSPHERE. Serafimov, K. B.; Koutiev, I. S. (Geophysical Inst., Sofia). Pure Appl. Geophys., 71: 20-5 (1968/III).

On the basis of the exponential approximation for the distribution of the concentration of molecular oxygen and ozone in given parts of the ionosphere, expressions were derived for the changes of the dissociative velocity rates of the oxygen components in the ionosphere. The numerical calculations made reveal negligible changes of these rates for heights above 100 km and sufficiently strong variations in the low ionosphere. (auth)

6928 DIURNAL VARIATIONS OF THE TEMPERATURE IN THE MIDDLE IONOSPHERE. Serafimov, K. B. (Geophysical Inst., Sofia). Pure Appl. Geophys., 71: 15-19(1968/III).

For the temperature of the middle ionosphere (100 to 180 km) variations proportional to the solar height are supposed with a certain inertia. The coefficients of these variations are computed on the basis of some rocket experiments and the asymmetry in the daily variations of the electron density in the E region, the intermediate E–F region and the F1 layer. The diurnal variations of the temperature are obtained for different constant heights. (auth)

6929 SUNRISE EFFECTS IN THE LOWER D-REGION BY SOLAR ECLIPSE. Nestorov, Georgi T. (Geophysical Inst., Sofia). Pure Appl. Geophys., 71: 5-14(1968/III).

In contrast to the well-known fact that the ionospheric absorption minimum falls behind the maximum phase of the solar eclipse, in the present work the reverse effect is discovered and analyzed, namely that the ionospheric absorption minimum falls before the maximum phase of the eclipse, while the maximum absorption comes behind it. Such anomalies can be observed only on paths of long waves at oblique incidence of the layer (length of the path over 1300 km). The theoretical analysis shows that the established effects are due to the considerable increase of the factor of negative ions, respectively of the effective recombination coefficient α' in the first phase of the eclipse for heights between 65 and 70 km, i.e., in the lower boundary of the D region (CR layer). In the second phase of the eclipse α' falls rapidly because of which at a constant electron production in CR layer a strong increase of the absorption is observed similar to the known sunrise effects in the D region. The electron drift is intensified about the maximum phase of the eclipse. (auth)

6930 IONOSPHERIC MEASUREMENTS FROM A ROCKET RADIO PROPAGATION EXPERIMENT. Beynon, W. J. G.; Rangaswamy, S. (Univ. Coll. of Wales, Aberystwyth). Planet. Space Sci., 16: 1349-56(Nov. 1968).

Some results obtained in a radio propagation experiment involving the recording of the pattern of pulse signals received at a rocket from a ground-based transmitter are described. The technique readily permits the group retardation of the radio signal at different levels in the ionosphere to be measured and the level of reflection to be determined. A ray tracing method is described which enables the electron density profile to be determined. (auth) (UK)

6931 MAPS OF THE DIFFERENCE IN GEOMAGNETIC FIELD AT CONJUGATE AREAS. Cole, K. D. (La Trobe Univ., Victoria); Thomas, J. A. Planet. Space Sci., 16: 1357-63(Nov. 1968).

World maps are presented which highlight certain features of the differences in the geomagnetic field at conjugate localities. These features are of particular interest in the field of conjugate aeronomic phenomena. (auth) (UK)

6932 EFFECT OF OXYGEN COOLING ON IONOSPHERIC ELECTRON TEMPERATURES. Dalgarno, A. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.); McElroy, M. B.; Rees, M. H. Planet. Space Sci., 16: 1371-80(Nov. 1968).

There are discrepancies between ionospheric electron temperatures derived from Thomson scatter data and electron temperatures predicted from the solar ultraviolet heat source. The inclusion of electron cooling by excitation of the fine-structure levels of atomic oxygen removes the discrepancy throughout the day at all altitudes above 320 km. Below this altitude a discrepancy persists, but it probably lies within the uncertainties arising from the basic atomic and molecular data employed in the theoretical analysis and from the solar-flux data. (auth) (UK)

6933 NEW MEASUREMENTS OF THE FLUORESCENCE EFFICIENCY OF AIR UNDER ELECTRON BOMBARDMENT. Hartman, Paul L. (Los Alamos Scientific Lab., N. Mex.). Planet. Space Sci., 16: 1315-40(Nov. 1968).

The fluorescence efficiency of air under electron bombardment was measured at a pressure corresponding to an altitude of 65 km, for electron energies around 700 eV, with the principal measurements at the bright 3914-Å band of the N_2^+ ion. Efficiencies for the 3914-Å band from two methods of observation were in good agreement, and gave a value of $\eta_{3914} = 0.34\%$. Spectra were obtained for air emission in the range of 2500 to 12,000 Å. Comparison of the radiation in the 3914-Å band to that in the whole spectrum gave a total efficiency of $\eta_T = 1.86\%$ for this spectral range. Efficiencies of other bands were also determined by comparison with the 3914-Å band. The 3914-Å efficiency, for electron energies of from 165 to 1000 eV, was found to be nearly independent of energy. The dependence on pressure of the light output in the spectral range 3000 to 11,000 Å was observed for electron energies of 750 and 1425 eV and pressures from 30 to 960 μ. The efficiency of the 3914-Å band is independent of pressure below 100 μ. Above 100 μ, efficiencies of the N_2^+ first negative and the N_2 first and second positive bands decrease with increasing pressure, the first positive decreasing most rapidly and the second positive least rapidly. Intensities of some N_2^+ Meinel bands were compared with the first positive (0, 0) band at pressures from 50 to 1 μ in nitrogen and air. The intensity of the Meinel bands relative to the first positive band increases by an order of magnitude over this pressure range in nitrogen. To check photometric techniques, the cross-section for excitation of the 3914-Å band by 750-eV electrons was measured and found to be in satisfactory agreement with results obtained by Holland. Some electron range measurements also gave results in agreement with previous work. (auth) (UK)

6934 OBSERVATIONS OF THE SCREENING OF SOLAR COSMIC RAYS BY THE OUTER MAGNETOSPHERE. Kane, S. R. (Univ. of Minnesota, Minneapolis); Winckler, J. R.; Hofmann, D. J. Planet. Space Sci., 16: 1381-1404(Nov. 1968).

Simultaneous observations by identical ionization chambers aboard the satellites OGO-I and OGO-III were utilized to investigate spatial variations in particle intensity near and inside the magnetosphere during the solar cosmic-ray events of September 1966. Cross-correlation of the absolute proton flux computed from the chamber rate during three solar particle events shows good agreement with the measurements by the IMP-F Solar Proton Monitor during the same events. The peak dosage measured during the September 1966 solar cosmic-ray events varied from 4×10^{-4} R/hr to 60 R/hr. The high sensitivity and absolute intercomparability of the instruments allowed small intensity differences to be detected, and it was established that the observed differences can be explained by a magnetospheric "screening" effect when an anisotropic beam of particles is present in space. Evidence is presented to show that the "screening" is at times complete for a duration of as much as 110 min in the tail of the magnetosphere, so that during this period the solar cosmic rays ($E \simeq 15$ MeV) have virtually no access to that region of the magnetosphere. Small intensity fluctuations of a temporal nature were observed and found to be subject to a damping effect inside the magnetosphere. (auth) (UK)

6935 PLASMAPAUSE AND ITS RELATION TO THE ION COMPOSITION IN THE TOPSIDE IONOSPHERE. Mayr, H. G. (Goddard Space Flight Center, Greenbelt, Md.). Planet. Space Sci., 16: 1405-14(Nov. 1968).

The high $O^+ - H^+$ transition level at latitudes above 50° and the plasmapause with its characteristic density plateau suggest that both features are strongly correlated; upward fluxes of protons

can consistently account for both observations. It is shown that plasma escape can produce sufficiently large fluxes at latitudes where the field lines are open, thus significantly decreasing the hydrogen-ion density. As a result, plasma diffusion across field lines is induced—coupled with upward fluxes of ionization along field lines, which leads to the formation of a plateau that characterizes the transition region from the open to the closed magnetosphere. Collision-type perpendicular diffusion would produce an enormously rapid transition over a distance of a few meters, which is not observed. This suggests that a turbulent state is built up in the transition region; thus, Bohm's (1949) coefficient for turbulent diffusion is employed, and this leads to a quantitatively satisfying description of the plasmapause. (auth) (UK)

6936 MID-LATITUDE O I GREEN EMISSION AND HIGH-ENERGY ELECTRON FLUX. Waddoups, R. O.; Baker, D. J. (Utah State Univ., Logan). Planet. Space Sci., 16: 1418-19 (Nov. 1968).

A twilight sounding rocket was flown on August 2, 1966, from Hawaii. The atomic oxygen green emission was measured with a vertically viewing photometer using an S-20 photocathode and an interference filter to spectrally isolate the 5577-Å emission. An electron counter was used to detect and count electrons precipitating into the upper atmosphere with energies greater than 15 keV, thereby providing a measure of the airglow emission attributable to normal auroral mechanisms. (UK)

6937 CHARACTERISTICS OF THE RESULTS OF THE MEASUREMENT OF IONOSPHERIC ABSORPTION USING A BEACON SATELLITE. Amayenc, P. Planet. Space Sci., 16: 1415-17 (Nov. 1968). (In French).

The results show that the limits of variations of parameter R, $L_{e,o}$, I, and $\bar{\nu}$ are: $0.5 < R < 6$ dB, $3 < L_{e,o} < 25$ dB, $1 \times 10^{20} < I < 100 \times 10^{20}$ el. m^{-2} sec^{-1}, and $0.5 \times 10^4 < \bar{\nu} < 6 \times 10^4$ coll. sec^{-1}, where R is the differential absorption between the ordinary (o) and extraordinary (e) component of the wave at reception; L is the total absorption; I is given by $S_{(h)} N\nu dh$; and $\bar{\nu}$ is the mean collision frequency as defined by Checcaui (1963). (UK)

6938 CORRELATED BURSTS OF VLF HISS, AURORAL LIGHT, AND X RAYS. Rosenberg, T. J. (Univ. of Bergen). Planet. Space Sci., 16: 1419-21 (Nov. 1968).

On March 23-24, 1966, a balloon carrying a NaI(Tl) scintillation counter recorded x rays (geometric factor = 10 cm^2) near Tromsø, Norway, while auroral luminosity and vlf hiss in a 10% band at 8 kHz were being monitored simultaneously from the ground. Four separate luminosity events occurred in the 4-hr interval when data were received from the balloon. Only one event, that near 0100 MET, was definitely related to the simultaneous occurrence of both x rays and auroral hiss and this is considered in some detail. (UK)

6939 FLICKERING: A 10-cps FLUCTUATION WITHIN BRIGHT AURORAS. Beach, R.; Cresswell, G. R.; Davis, T. N.; Hallinan, T. J.; Sweet, L. R. (Univ. of Aaska, College). Planet. Space Sci., 16: 1525-30 (Dec. 1968).

Visually, and with image orthicon television systems, a 10 ± 3 cps intensity variation has been observed in bright homogeneous auroras just prior to and during breakup. It was observed simultaneously at conjugate locations in the northern and southern hemispheres and at several other locations in the northern hemisphere. This phenomenon is called "flickering"; it has characteristics which clearly distinguish it from other types of pulsing auroras. (auth) (UK)

6940 THE POLAR SUBSTORM AND ELECTRON "ISLANDS" IN THE EARTH'S MAGNETIC TAIL. Rothwell, P.; Wallington, V. (Univ. of Southampton, Eng.). Planet. Space Sci., 16: 1441-52 (Dec. 1968).

The behavior of energetic electrons in the distant magnetosphere near the midnight meridian during polar substorms was studied for the period March 5th-April 4th, 1965, using data from two end window Geiger counters flown on the IMP 2 satellite (apogee 15.8 R_E) and magnetic records from a chain of auroral zone stations around the world at magnetic latitudes equivalent to L = 7.4 ± 2.0. When the satellite was in the distant radiation zone or in the plasma sheet which extends down the Earth's magnetic tail, sudden decreases in the horizontal magnetic field component at ground stations near the midnight meridian (negative magnetic "bays") were followed by sudden increases in 40 keV electron fluxes (electron "islands") at the satellite. When the satellite was at high latitudes in the magnetic tail, "bays" often were not followed by "islands." When the satellite was near the center of the plasma sheet, energetic electron fluxes were observed even during magnetically quiet periods. The time delay between the sharp onset of magnetic bays in the auroral zone and the corresponding rapid increase in energetic electron intensity at the satellite, typically some tens of minutes, was least when the satellite was close to the Earth and increased with increasing radial distance from the Earth. The delay was also a function of distance of the satellite from the center of the plasma sheet, and of the magnitude of the intensity increase (smaller delays for larger intensity increases). It is deduced that the disturbance producing the magnetic bays and associated particle acceleration originates fairly deep in the magnetosphere and propagates outward to higher L values, and down the plasma sheet in the Earth's magnetic tail on the dark side of the Earth. It is unlikely that the accelerated electrons are themselves drifting away from the Earth, because the apparent velocity with which the islands move away from the Earth decreases with increasing distance from the Earth. It is suggested that the polar substorm and the associated particle acceleration are part of an impulsive ejection mechanism of magnetospheric energy into the ionosphere, rather than an impulsive injection mechanism of solar wind energy into the magnetosphere. (auth) (UK)

6941 FAST AURORAL WAVES. Cresswell, G. R. (Univ. of Alaska, College). Planet. Space Sci., 16: 1453-64 (Dec. 1968).

The described auroral waves are east-west aligned arc-like features that have been observed to propagate southward at 50 to 300 km/sec in the College vicinity after midnight. They occurred only when the preceding daylight hours, and often the evening hours, were magnetically undisturbed, and always after a short-lived (1 to 2 hr) polar substorm. It is suggested that the waves are the result of hydromagnetic processes occurring near the equatorial plane. (auth) (UK)

6942 RADIO SCINTILLATIONS PRODUCED BY IRREGULARITIES AT SPORADIC-E LEVEL. Jones, K. L. (Univ. of Queensland, Brisbane). Planet. Space Sci., 16: 1475-82 (Dec. 1968).

Different observers assign differing degrees of importance to sporadic-E irregularities in producing amplitude variations (scintillations) in radio star and satellite transmissions. The most reliable index of the effect of sporadic-E in this respect was found to be the difference between critical and blanketing frequencies. It is shown how an apparent contradiction between the results of different observers may be resolved. (auth) (UK)

Low-Temperature Physics

Refer also to abstracts 6246-6251, 6313, 6753, 7200, and 7401.

6943 (BNL-13021) NIOBIUM-TIN AND RELATED SUPERCONDUCTORS. Britton, R. B. (Brookhaven National Lab., Upton, N. Y.). [1968]. 18p. Dep. CFSTI.

Present knowledge of the superconducting compounds and their properties, and who is developing each type is reviewed. Experiences with several conductors and a technique for testing a complete conductor prior to using it in a device are reviewed also. To show where the compounds fit into superconductivity, comparative data about a few of the compounds, alloys, and elements are tabulated. (M.H.R.)

6944 (SC-T-68-1552) FAST LIBERATION OF ENERGY STORED USING SUPERCONDUCTORS. Prost, Gerard; Sole, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from report CEA-R-3255. 40p. Dep. CFSTI.

After a rapid description of the circumstances in which they first thought of using superconducting materials for the storage and liberation of energy, the authors examine, in comparison to condensers, the energy densities which can thus be stored, the methods used for introducing this energy into the superconducting circuit and for trapping it, and the law governing the discharge of this energy into a purely dissipative impedance. This leads to a derivation of the expression for the energy yield which depends on the characteristics of the switch used for opening the superconducting circuit. An experimental study was made of a superconducting switch with a view to understanding the various parameters. As a result of this analysis, transitions of this switch, over the whole of its mass, were obtained for periods of a few microseconds, and energy yields close to unity were obtained. The obtention of fast discharges is now no longer a technological problem. (auth)

6945 INFLUENCE OF HIGH PRESSURE ON THE ENERGY GAP OF TIN. Galkin, A. A.; Dikii, A. A.; Svistunov, V. M. (Inst. of Technical Physics, Donetsk, USSR). Phys. Status Solidi, 30: K107-10 (Dec. 1, 1968).

Experimental measurements are reported of the energy gap Δ of superconducting tin from 1.3 to 4.2°K for pressures up to 11 K/atm

on Al/I/Sn and Sn/I/Sn junctions. The pressure dependences of T_c and Δ are found to be: $dT_c/dP = -4.8 \pm 0.3 \times 10^{-5}$ °K atm, and $d2\Delta/dP = +1.85 \pm 0.1 \times 10^{-5}$ MeV/atm. The change in $2\Delta/kT_c$ with pressure coincides with that in T_c/Θ_D. The role of fluctuations in the dc Josephson tunneling is pointed out. (D.L.C.)

6946 THERMODYNAMICS OF ^{3}He AND ^{4}He AT LOW TEMPERATURES. Semenchenko, V. K.; Badra, Kh. M. Zh. Fiz. Khim., 42: 2045-9(Aug. 1968). (In Russian).

The possibility of a lambda transition in ^{3}He at very low temperatures was found in a series of theoretical works. The analysis of experimental data conducted by the methods of the stability theory confirmed this possibility. (tr-auth)

6947 MAGNETIC FLUX PENETRATION IN TYPE-II SUPERCONDUCTORS. Carlson, David Emil. New Brunswick, N. J., Rutgers-The State Univ., 1968. 133p.

Thesis.

The penetration of a small oscillating field into niobium and indium–bismuth alloys was investigated in the presence of a steady magnetic field, which ranged from zero to above H_{c3}. Changes in the oscillating flux were measured using the technique of Schawlow and Devlin (Phys. Rev., 113: 120(1959)) at frequencies of the order of 1 Mc. Hydrodynamic theories of vortex motion, as well as theories for collective vortex oscillations, are compared with the experimental results. Under certain circumstances, the penetration depth behavior in the mixed state can be interpreted in terms of the dc flux-flow resistivity. The effects of vortex pinning are discussed. Theories for the average order parameter and the critical state of the superconducting surface sheath are compared with experiment. An extension of the calculations of Matricon and Saint-James (Phys. Letters, 24A: 241(1967)) is suggested in order to determine the magnetization of thin cylindrical films and the critical state of the surface sheath. (Disser. Abstr.)

6948 HELIUM REFRIGERATOR: INSTALLATION TYPE AND AIR-BORNE TYPE. Yamaguchi, Masami; Gotoh, Koh (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rev., Int. Ed., No. 38, 47-9(Sept.-Oct. 1968).

A 4 to 20°K helium refrigerator of the installation type has been developed. Tests are being made on a prototype 20°K helium refrigerator of the airborne type, in which the movement of the piston in the expansion engine can take place with less friction, and a new rotary joint is applied in a part of the vacuum pipings to evacuate the cryostat. (auth)

6949 SUPERCONDUCTIVITY OF Sn–In ALLOYS. II. RESONANT FREQUENCY OF THE TANK CIRCUIT CONTAINING THE SPECIMEN AS A CORE AND THE AC MAGNETIC SUSCEPTIBILITY. Aomine, Takafumi (Kyushu Univ., Fukuoka). J. Phys. Soc. Jap., 25: 1585-96(Dec. 1968).

The resonant frequency f of a tank circuit containing the specimen as a core plotted against y where y was $1/\sqrt{1-(T/T_c)^4}$, showed a knee irrespective of the In concentration. Such a behavior was attributed to the appearance of eddy current loss in a specimen at temperatures above the temperature T* where the knee occurred. This conclusion was deduced from the results of measurement of the imaginary part χ'' of the ac magnetic susceptibility and the resonant frequency in an external, static, magnetic field. The magnetic field-dependence of the resonant frequency at temperatures above T* was different from that at temperatures below T*. At temperatures above T*, there was a maximum followed by a minimum in the $\Delta f - H$ curve, where $\Delta f = f(0) - f(H)$. On the other hand Δf at temperatures below T* was approximately quadratic in H. It was found from the measurement of the ac susceptibility that a differential paramagnetism appeared at temperatures near the critical temperature. (auth)

6950 DESTRUCTION OF JOSEPHSON CURRENT BY FLUCTUATIONS. Ivanchenko, Yu. M.; Zil'berman, L. A. (Donetsk Physical-Technical Inst., Kiev). JETP Lett. (USSR) (Engl. Transl.), 8: 113-15(Aug. 20, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 189-92(Aug. 20, 1968).

A system consisting of a Josephson contact connected to an ideal current generator is considered. The potential energy of the system may be written in the form $U(\phi) = -[(\hbar/2e)(I_0 \cos \phi + I\phi)]$, where ϕ is the phase difference between the two superconductors. The destruction of current in this system is discussed. (M.O.W.)

6951 HELIUM REFRIGERATORS FOR A NUCLEAR RESEARCH INSTITUTE. Pagani, P.; Giger, U. (Sulzer Bros. Ltd., Winterthur, Switzerland). pp 39-43 of Proceedings of 2nd International Cryogenic Engineering Conference, Brighton, Eng., 7–10 May 1968. Guildford, Eng., Iliffe Science and Technology Publications Ltd., 1968.

See CONF-680505.

Two multipurpose helium refrigerators have been erected in the nuclear research centre at Jülich, West Germany. Both plants are fitted with two turbo-expanders and work without any precooling. The first plant, which was erected in 1966, is used to cool samples which are irradiated with high-energy electrons generated in a Van de Graaf linear accelerator. The second plant, with a capacity of 1,000 W at 14.5°K, was erected in 1967. A short description of the cycles and the plant components is given, and some relations between the experiments performed and the refrigerators are shown. (auth) (UK)

6952 TECHNIQUES FOR EVALUATING THE PERFORMANCE OF THE ^{3}He DILUTION REFRIGERATOR. London, H. (Atomic Energy Research Establishment, Harwell, Eng.); Phillips, D.; Thomas, G. P. pp 55-8 of Proceedings of 2nd International Cryogenic Engineering Conference, Brighton, Eng., 7–10 May 1968. Guildford, Eng., Iliffe Science and Technology Publications Ltd., 1968.

See CONF-680505.

In order to assess and control the performance of the Harwell helium-3–helium-4 dilution refrigerator it is desirable to monitor several of the physical parameters of the system without disturbing the cooling cycle. Accurate methods of measuring temperatures, mixture circulation rates and concentrations of the helium-3 and helium-4 isotopes in the mixture, and techniques developed for handling and separating the mixed isotopes, are described. Temperatures are measured with a susceptibility thermometer. The gas circulation rates are measured by Kronberger's calorimetric flow method. The concentrations of helium-3 and helium-4 in the circulating mixture are determined with a modified mass-spectrometer leak detector. The mixture of helium isotopes is transferred to and from the cryostat and the storage volumes by a simple, effective and reliable absorption pump; the use of this pump for the separation of helium-3 from the mixture is also described. (auth) (UK)

6953 Nb–Zr–Ti TERNARY ALLOY IN SUPERCONDUCTING MAGNETS. Doi, T.; Kimura, H.; Kudo, M.; Kawabe, U. (Hitachi Ltd., Tokyo). pp 167-71 of Proceedings of 2nd International Cryogenic Engineering Conference, Brighton, Eng., 7–10 May 1968. Guildford, Eng., Iliffe Science and Technology Publications Ltd., 1968.

See CONF-680505.

Superconducting strips made of superconducting Nb–Zr–Ti (HISUPER-X) alloy wires embedded in-parallel in the pure copper substrate were developed as the winding materials of superconducting magnets for an MHD generator and for a bubble chamber. The 20-cm bore superconducting saddle-shaped magnet and 8-cm-bore superconducting solenoid wound with these strips were constructed and tested in liquid helium. (auth) (UK)

6954 THEORETICAL EVALUATION OF HIGH-FIELD MEASUREMENTS ON TYPE-II SUPERCONDUCTORS UP TO 230 kOe. Hechler, K.; Sauer, E. (Univ. of Giessen, Ger.). pp 172-4 of Proceedings of 2nd International Cryogenic Engineering Conference, Brighton, Eng., 7–10 May 1968. Guildford, Eng., Iliffe Science and Technology Publications Ltd., 1968.

See CONF-680505.

High-field measurements on type-II superconductors of β-tungsten structure compounds (Nb_3Al, Nb_3Sn, V_3Si and V_3Ga) and interstitial compounds (NbN with and without admixtures of Ti, Zr and Ta) were evaluated for critical fields for comparison with theory. (auth)

6955 EXPERIMENTS ON COPPER- AND ALUMINIUM-STABILISED Nb–Ti SUPERCONDUCTORS IN VIEW OF THEIR APPLICATION IN LARGE MAGNETS. Bogner, G.; Albrecht, C.; Maier, R.; Parsch, C. P. (Siemens AG, Erlangen, Ger.). pp 175-8 of Proceedings of 2nd International Cryogenic Engineering Conference, Brighton, Eng., 7–10 May 1968. Guildford, Eng., Iliffe Science and Technology Publications Ltd., 1968.

See CONF-680505.

Measurements of the critical current and recovery current of copper- and aluminium-stabilized Nb–Ti conductors are reported. In addition, results on the current transfer length from the normal conductor to the superconductor (to control the bond quality) are given. The electrical properties of the stabilizing materials under magnetic field and mechanical forces are also discussed. Experimental results on some small stabilized test magnets are given. Design data and experimental results on a larger magnet system built for CERN are also given. This system worked at 1,000 A with a clear bore of about 400 mm, a central field of 60 kOe, and a stored energy of about 2 MJ. (auth) (UK)

6956 CONTACT RESISTANCE OF STABILISED SUPERCONDUCTING WIRES. Furuto, Y.; Ikeda, M. (Furukawa Electric Co. Ltd., Tokyo). pp 179-83 of Proceedings of 2nd International Cryogenic Engineering Conference, Brighton, Eng., 7-10 May 1968. Guildford, Eng., Iliffe Science and Technology Publications Ltd., 1968.

See CONF-680505.

A new method for measuring contact resistance of composite conductors is proposed and some measurements of contact resistance and resistance ratio (300°K/4.2°K) of various stabilized superconducting wires are discussed. Stabilized superconducting wires, copper electroplated wires (NbZr or NbTi) and mechanically bonded wires (NbTi) showed a contact resistance of about 0.05 μohm/cm^2, which is considerably lower than for commercially available wires. The resistance ratios of mechanically bonded wires with OFHC copper were better than electroplated wires, as expected. The formation of an intermetallic compound was detected by the proposed method. A jump in contact resistance was found near the transition temperature of the superconductor. (auth) (UK)

6957 SOME MEASUREMENTS ON THE SUPERCONDUCTING PROPERTIES OF THIN MERCURY FOILS. Van Itterbeek, A.; Bruynseraede, Y.; Deprez, E. (Inst. of Low Temperature Physics, Louvain, Belgium). pp 184-6 of Proceedings of 2nd International Cryogenic Engineering Conference, Brighton, Eng., 7-10 May 1968. Guildford, Eng., Iliffe Science and Technology Publications Ltd., 1968.

See CONF-680505.

In order to investigate the influence of α radiation on the superconducting properties of mercury, thin mercury foils (20 μ) were of interest. A simple but efficient method is described for preparing the foils, measuring their thickness and making electrical contacts. Preliminary measurements indicated that the superconducting properties (T_c and H_c) of the mercury foils are in good agreement with those reported for mercury wires. (auth) (UK)

6958 HOMOPOLAR MACHINE WITH SUPERCONDUCTING INDUCTOR. Bonnefille, R.; Chabrerie, J. P.; Fournet, G.; Mailfert, A.; Robert, J.; Vaillant, C. (Laboratoire Central des Industries Electriques, Fontenay-aux-Roses, France. Faculte des Sciences, Paris). pp 187-9 of Proceedings of 2nd International Cryogenic Engineering Conference, Brighton, Eng., 7-10 May 1968. Guildford, Eng., Iliffe Science and Technology Publications Ltd., 1968. (In French).

See CONF-680505.

A homopolar machine having a superconducting field winding and multiple rotating discs is described. A method of finding the optimum coil and armature dimensions is also described, and two new devices using liquid metals for the electrical contacts of the armature are discussed and their properties compared. (auth) (UK)

6959 A 7-W, 4.5°K HELIUM REFRIGERATOR: APPLICATION OF SUPERCONDUCTING COILS TO REFRIGERATION BY GASEOUS CONVECTION. Solente, P.; Marinet, D. (Centre d'Etudes Cryogeniques, Isere, France). pp 23-6 of Proceedings of 2nd International Cryogenic Engineering Conference, Brighton, Eng., 7-10 May 1968. Guildford, Eng., Iliffe Science and Technology Publications Ltd., 1968. (In French).

See CONF-680505.

A refrigerator with a cooling capacity of 7 W at 4.5°K is described. The principle is based on the association of a Stirling cycle with a Joule-Thomson expansion cycle. High-pressure helium is precooled to 15°K with the help of a Philips cryogenerator, is then further cooled in a counter flow heat exchanger, and is expanded in a Joule-Thomson valve. The liquid-gas mixture circulates in a heat exchanger around the cryogenic vessel. Power is dissipated inside the vessel by free convection heat exchange. A temperature of 4.5°K inside the vessel is satisfactorily maintained. The definition and stability of the temperature is to 0.03°K. Two electrical connections are mounted in the vessel and are cooled at 120°K and 30°K by means of heat exchangers associated with the refrigerator. It was possible to introduce a current of 140 A in the cold volume of 8.5 dm^3 at a temperature lower than 5°K. A magnetic field of 50 kG was obtained with a niobium-zirconium superconducting coil inside the cold volume. The maximum magnetic field of this magnet immersed in liquid helium was 56 KG. (auth) (UK)

6960 SHORT HELIUM DEWAR FOR HIGH-CURRENT SUPERCONDUCTING COILS. Deiness, S.; Coville, P. (Sodern SA, Suresnes, France). pp 139-40 of Proceedings of 2nd International Cryogenic Engineering Conference, Brighton, Eng., 7-10 May 1968. Guildford, Eng., Iliffe Science and Technology Publications Ltd., 1968.

See CONF-680505.

With the usual conception of Dewars a necessary difference exists between levels of liquid nitrogen and helium. A simple means for eliminating this difference without increasing the losses is described. The total height of the apparatus is reduced by more than 20 cm (8 in.) for a similar helium capacity. The device is especially convenient for superconducting coils, giving short and rigid assembly, with a free top. The introduction of high current leads through the nitrogen bath is easy and the current leads are simplified. (auth) (UK)

6961 PROCEEDINGS OF THE SECOND INTERNATIONAL CRYOGENIC ENGINEERING CONFERENCE, BRIGHTON, ENG., 7-10 MAY 1968. Guildford, Eng., Iliffe Science and Technology Publications Ltd., 1968. 312p. £10. CONF-680505.

The conference comprised 78 papers, presented under the following section headings: Refrigeration; handling; superconductivity; thermometry; properties; space simulation and cryopumping; research equipment. Separate abstracts are given for 16 papers. (UK)

For abstracts of individual papers see: 6246-6960.

6962 FORMATION OF ECHOES IN TYPE-II SUPERCONDUCTING POWDERS. Ehrenfreund, E.; Goldberg, I. B.; Weger, M. (Hebrew Univ., Jerusalem). J. Appl. Phys., 39: 5941-2(Dec. 1968).

A mechanism which accounts for the observed echoes in various systems, such as type-II superconducting powders, is proposed. The model proposed accounts for the dependence of the echo amplitude on the exciting power, but does not specify the origin of the echoes. (auth)

6963 SUPERFLUIDS. Hall, H. E. (Univ. of Manchester, Eng.). Phys. Bull. (London), 19: 409-13(Dec. 1968).

This review paper gives a semihistorical outline of the salient experimental and theoretical results that have contributed to the present understanding of superfluidity, under the following headings: Introduction; unquantized superflow; time-independent quantization; time-dependent quantization; origin and stability of quantized flow. (UK)

6964 SIMPLE DEMONSTRATION OF VOLTAGES GENERATED BY VORTEX MOTION IN TYPE-II SUPERCONDUCTORS. LeBlanc, M. A. R.; Chang, C. T. M. (Univ. of Southern California, Los Angeles). J. Appl. Phys., 39: 6044-8(Dec. 1968).

A signal generated between the terminals of an open superconducting coil is made to vary by as much as ±50% by introducing a net temperature gradient when flux trapped in the body of the coil is thermally destroyed. The sign and magnitude of the variations are determined by the sign and magnitude of the net temperature gradient. The signal observed with no net temperature gradient present as $T \rightarrow T_c$ and the trapped flux is expelled arises from Faraday induction. The variations in the signal are attributed to preferential vortex migration toward the hot surface of the sample. A simple modification of the arrangement is described where the classical Faraday signals are made to cancel out and the flux motion signal alone is observed. (auth)

6965 HIGH PRESSURE SYNTHESIS AND SUPERCONDUCTING PROPERTIES OF YTTRIUM SESQUICARBIDE. Krupka, M. C.; Giorgi, A. L.; Krikorian, N. H.; Szklarz, E. G. (Los Alamos Scientific Lab., N. Mex.). J. Less-Common Metals, 17: 91-8(Jan. 1969).

The bcc Pu_2C_3-type structure of yttrium sesquicarbide, Y_2C_3, was prepared in high yield by high-pressure and high-temperature techniques. Lattice parameter measurements indicated a homogeneity range for the compound. Magnetic susceptibility measurements showed the material is superconducting over the entire homogeneity range with the superconducting transition temperature varying from a low of 6.0°K to a high of 11.5°K. High-temperature and ambient pressure annealing of samples prepared by the high-pressure and high-temperature techniques destroyed the Pu_2C_3-type structure. No superconducting transition was observed on the annealed samples for measurements down to 2.0°K. (auth)

Plasma and Thermonuclear Physics

6966 (AED-C-3-24) PLASMA PHYSICS INDEX. EXPERIMENTAL AND THEORETICAL PLASMA PHYSICS. Volume 3, No. 9. Bibliography; Author Index; Subject Index. Hilsenbeck, D. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). 1968. 209p. Dep.

Four-hundred ninety eight articles on various aspects of plasma physics are listed. Subject and author indexes are included. (M.O.W.)

6967 (TID-24804) PERSPECTIVES ON CONTROLLED THERMONUCLEAR RESEARCH: A REPORT ON THE THIRD IAEA CONFERENCE AT NOVOSIBIRSK, AUGUST 1968. Hirsch, Robert L. (ed.) (Atomic Energy Commission, Washington, D. C.). Oct. 1968. 125p. Dep. CFSTI.

Summaries on the state of progress of CTR are given for the following: (1) low β toroidal systems, (2) low β open systems, (3) high β compression systems, (4) Astron, (5) laser plasma and laser focus, (6) plasma heating techniques, (7) collisionless shock waves, (8) basic plasma physics and gas bounded plasma, (9) computer simulation and general plasma theory, and (10) technological problems of controlled thermonuclear power. (M.O.W.)

Confinement and Heating

6968 (IPP-1/82) PLASMA LOSSES IN A TOROIDAL THETA PINCH WITH SUPERPOSED HEXAPOLE. Junker, J.; Lotz, W. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). May 1968. 31p. Dep.

A toroidal theta-pinch discharge with superposed nonhelical hexapole field is investigated. The characteristic data of the discharge are: major diameter 52 cm, minor inner diameter of the vacuum vessel 6 cm, maximum magnetic field between 10.5 and 21 kG, rise time (quarter-cycle) 3.0 μs, maximum temperature between 40 and 100 eV, maximum density between 1 and 3×10^{16} cm^{-3}, beta values between 0.3 and 1.0. The plasma loss rates are determined by measuring particle density, temperature, and plasma radius. The loss rates are compared with loss rates of models which account for cusp losses, resistive losses, and Bohm diffusion. Measured loss rates are consistent with those expected from cusp losses with a cusp slit width of one ion gyroradius. Above electron temperatures of 20 eV, resistive losses are negligible. Bohm diffusion is not consistent with the measurements, but is of the same order of magnitude. Measurements with "alternating hexapole" showed higher loss rates. The machine is now being converted into a 1 = 3 "fast stellarator" configuration, i.e., a toroidal theta pinch with superposed helical hexapole field. (auth)

6969 (IPP-1/85) SWITCHES FOR HIGH CURRENT DEVICES. Wilhelm, R. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Aug. 1968. 31p. (In German). Dep.

The properties of the several switches used in high-current devices are described. In particular, the air-pressured spark gaps, the ferrite-decoupled crowbar switches, and a solid dielectric switch are described which are in use at the fast θ-pinch experiment Isar IV. (auth)

6970 (IPP-1/86) RADIATION LOSSES OF A HIGH DENSITY Z-PINCH. Kaufmann, M. (Institut fuer Plasmaphysik, G.m.b.H. Garching (West Germany)). Aug. 1968. 53p. (In German). Dep.

The radiative losses of a high-density Z pinch ($n_e = 10^{19}$ cm^{-3}) were investigated experimentally. When the compressed column has a temperature of 10 eV, the radiative losses were determined by a special measuring method in which the vacuum uv radiation was resolved in time and recorded by means of an open photocell. This method also involved absolute, but time integrated measurement of the radiation by means of a thermopile. It was possible to achieve a certain resolution of the radiation wavelength by filling a volume between the light source and the detectors with various absorbing gases in succession. The radiative losses of the pinch were determined from these measurements by deconvolution. It was found that the major part of the internal energy of the plasma was lost by radiation. (auth)

6971 (IPP-1/87) ION HEATING IN A VERY FAST THETA PINCH. Wilhelm, R. (Institut fuer Plasmaphysik, G.m.b.H. Garching (West Germany)). Aug. 1968. 62p. (In German). Dep.

In a theta pinch with an extremely fast rising magnetic field ($dB/dt > 10^{11}$ G/sec), a strong compression wave is produced in an initially fieldless low-density deuterium plasma. Assuming simple plasma models, a high-energy gain of the ions is expected during the implosion of the plasma. In agreement with these calculations for a 20-μ filling pressure of D_2, a mean ion energy of 1 to 2 keV is determined from the first neutron emission at the end of the implosion, only 150 nsec after ignition. Decreasing the initial pressure to 10 μ of D_2 does not cause any further increase of the achieved ion energy. This limitation of the ion heating is explained by a strong broadening of the current carrying layer at low densities which is observed by magnetic probe measurements. In the adiabatic compression, the mean ion energy attains values of several keV. During the first part of this phase, the energy distribution function of the ions is found to be essentially anisotropic and monoenergetic rather than Maxwellian. (auth)

6972 (LA-tr-68-43) EQUILIBRIUM OF A PLASMA OF FINITE PRESSURE IN A STRAIGHT STELLARATOR. Vekshtein, G. E. Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from Preprint. 10p. Dep. CFSTI.

The equilibrium of a plasma of finite pressure in a three-turn helical magnetic field and its effect on the integral characteristics of confinement (volume per unit flux V', rotational transform) are considered. It is shown that even at $\beta_0 \ll 1$ they can differ considerably from those for a vacuum. (auth)

6973 (NP-17707) CONFINEMENT OF PLASMA WITH HIGH-FREQUENCY FIELDS. Rijnhuizen Report 68-46. Hagebeuk, H. J. L. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Oct. 1968. 82p. Dep.

A description is given of a highly ionized hydrogen plasma in a strong uniform magnetostatic field. On one side the axial leak of electrons is suppressed by the time-average force exerted by a nonuniform hf electric field which is mainly parallel to the magnetostatic field and which decreases towards the plasma. On the other side the electrons are confined by an electrostatic field. The confinement of electrons gives rise to a negative space charge potential which confines the ions. From numerically calculated orbits of electrons which are reflected nonadiabatically by the hf field an expression is derived for the energy gain. It can be of the same order of magnitude as the energy gained by electrons in collisions with heavy particles in the hf field region. The influence of the energy gain on the energy distribution of electrons is calculated. Experimentally, a steady state is reached in which the electron density ($\sim 3 \times 10^{14}$ m^{-3}), the electron temperature (kT $\sim$ 30 eV), and the ionization degree ($\sim$10%) satisfy an equation which expresses the energy balance. In the case that the hf barrier is lower than the electrostatic barrier, instabilities occur on either side of the resonance curve of the cavity due to the fact that the pressure balance or the energy balance of the plasma are unstable for small perturbations of the height of the hf barrier. The propagation of electromagnetic waves in a cold, strongly magnetized plasma with a parabolic density profile in a cylindrical waveguide is studied. An experiment is described in which it is demonstrated that, in a cylindrical waveguide which is beyond cutoff without plasma, Tm-modes start to propagate at a critical value of the electron density corresponding to the plasma frequency. Measurements of the transmission agree with the theoretical calculations. The shift of the resonance frequency of a cavity in which a plasma is present depends on the strength of a magnetostatic field, and can be zero at a critical field strength above cyclotron resonance as is shown. By a suitable choice of the hf mode and the magnetostatic field pattern the plasma can be confined in equilibrium with these fields. (auth)

6974 (SC-T-68-1551) DISCHARGE OF A CONDENSER BATTERY. Belitz, Hans-Joachim; Kugler, Erwin. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Elektrotech. Z., 87A: 560-3 (1966). 14p. Dep. CFSTI.

The harmonic vibrations that occur during the discharge of condenser batteries are analyzed. The amplitudes and frequencies are obtained. A FORTRAN program was used in the calculations. (M.O.W.)

6975 TRANSPORT PROCESSES IN TOROIDAL SYSTEMS. Kovrizhnykh, L. Preprint No. 98. Moscow, Lebedev Inst. of Physics, 1968. 18p. (In Russian).

Expressions for particle flux and energy across magnetic fields in toroidal magnetic traps of various types (Tokamak, Levitron, Stellarator, and corrugated torus) are presented. Fully and weakly ionized plasmas were examined. From the expressions obtained it follows that taking account of toroidalness leads to sufficiently small collision frequency and to a substantial increase in the coefficients of diffusion and thermal conductivity in comparison with nontoroidal systems. It was found for a certain range of parameters (small collision frequency or sufficiently large electric field) that the transfer coefficients do not depend upon the magnitude of the magnetic field. (tr-auth)

Diagnostics

6976 (IPP-1/84) METHOD FOR CALIBRATION OF THE MEASUREMENT APPARATUS BY SCATTERED MEASUREMENTS IN HOT PLASMAS. Stoye, P. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). May 1968. 42p. (In German). Dep.

A device for calibrating the measuring apparatus used in laser-scattering experiments on hot plasmas is described. Calibration is done here by means of a light pulse which is very similar in shape to the laser light pulse (half-width 10 nsec) and which has a

spectral range of 6000 to 8000 Å. The scattered light and calibrating light follow the same path through the device. Forming the ratio between the two signals in this way eliminates errors not taken into account in the usual stationary method of calibration. The 10-nsec calibrating pulse is generated with a Kerr cell. The voltage pulse for the cell is produced by a cable discharge. The light source is a pulsed ultrahigh-pressure mercury arc. Relative calibration shows the measuring apparatus to have an error of 10 to 12% for the scattered light signals. In absolute calibration the error is between 24 and 31%. The device is being used for relative calibration in scattering experiments for determining the temperature and density of theta-pinch plasmas. (auth)

6977 (IPP-3/77) INFLUENCE OF RELAXATION EFFECTS ON SPECTROSCOPIC TEMPERATURE MEASUREMENTS OF A STATIONARY HYDROGEN ARC IN AN AXIAL MAGNETIC FIELD. Tichmann, K. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). July 1968. 52p. (In German). Dep.

The radial temperature distribution in a 2400-A hydrogen arc in a 35-kG axial magnetic field was measured spectroscopically. Temperatures in the range 20,000 to 60,000°K were determined from the ratio of the intensity of the Balmer H_β line to the neighboring continuum. For measuring temperatures above 40,000°K a small quantity of helium was added to the hydrogen. The temperature was then determined from the intensity ratio of a He II to a He I line using the corona equation as the ionization equation between He^{++} and He^{+}. At temperatures at which the two measuring methods could be used simultaneously there were strong deviations between the results. These deviations were attributed to radial flow of helium ions. If, for example, the helium ium^{++} ions stream outwards into colder regions as a result of ambipolar diffusion or mass flow, they produce an additional contribution to the $helium^{++}$ particle density at a certain location because of their finite recombination time. Therefore, the number of $helium^{++}$ particles actually present there is larger than that calculated from the static ionization formula (corona formula). The momentum equations for a four-component plasma (hydrogen ions, electrons, $helium^{++}$ ions, and $helium^{+}$ ions) in a magnetic field were used to calculate the radial velocities of the helium particles for small helium admixtures. The expressions obtained for the velocities were substituted in the ionization rate equation for the $helium^{++}$ particles. It was thus found that the corona equation is not applicable under the conditions present in the arc investigated (electron density about 2×10^{15} cm^{-3}, temperature gradient about 10^5°K/cm, magnetic field 35 kG). It is concluded that temperature can be satisfactorily determined from measurements of the line intensity ratio He II/He I using the corona formula only at magnetic fields above 120 kG, at the arc axis. (auth)

6978 TEMPERATURE AND ELECTRON-DENSITY DETERMINATIONS IN HIGH-PRESSURE RARE GAS PLASMAS. Spiegelhalter, Fritz (Univ., Karlsruhe, Ger.). Beitr. Plasmaphys., 8: 1-19(1968). (In German).

In high-pressure plasmas, high terms, especially those with large azimuthal quantum numbers, are affected sensitively, principally by the quadratic Stark effect and to a smaller degree by the Van der Waals interaction. The expansion of suitable terms was experimentally determined, and those expansion fractions which are caused by the perturbation of ions, electrons, and neutral particles are investigated. The profile of the Stark effect-sensitive spectral lines deviate from the dispersion profiles and are asymmetric. The character of the asymmetry was determined by the perturbations of the ions, which obey the statistical theory in good approximation under operating conditions from 7- to 19-atm pressure and 6- to 30-A load. The perturbations of the electrons and neutral particles can be described approximately by the shock absorption theory. The line profiles observed can be described as the folding of three profiles: two dispersion profiles resulting from the electron collision and Van der Waals propagation and the superposition of the statistical ion profile. The agreement between the measured and theoretically described profiles is very good. For the temperature and electron density determinations, the fraction of the electron collision and Van der Waals widths were determined from the total half widths of the lines. By calculation of the Van der Waals width, which contributes only slightly to the line propagation, the electron collision width is obtained and the temperature and electron density values are obtained from the Saha equation. (tr-auth)

6979 COMPOSITION OF A THERMAL MERCURY PLASMA IN THE TEMPERATURE REGION BETWEEN 1,000 AND 15,000°K AT PRESSURES BETWEEN 10 TORR AND 50 ATM. Irmer, J.; Worm, M. (Physikalisch-Technisches Institut, Berlin). Beitr. Plasmaphys., 8: 217-32(1968). (In German).

The present work is concerned with the calculation of the particle concentration of a mercury vapor plasma in the pressure range from 10 torr to 50 atm at temperatures between 1,000 and 15,000°K under the hypothesis of thermal equilibrium. The necessary theoretical principles were described, and the calculation results were given in the form of tables and graphic representations. (tr-auth)

6980 DETERMINATION OF THE SPECTRAL ABSORPTIVITY OF A PULSED DISCHARGE PLASMA FROM SPECTRAL DENSITY OF ITS RADIANCE. Charnaya, F. A. Opt. Spectrosc. (USSR) (Engl. Transl.), 25: 11-12(July 1968).

Translated from Opt. Spektrosk., 25: 24-7(July 1968).

The possibility of obtaining data on the absorptivity of a discharge plasma from measurements of spectral density of radiation brightness is demonstrated. Curves obtained by this method show the dependence of the absorption coefficient on wavelength for a pulsed discharge in argon (P = 6 atm) and xenon (P = 0.6 atm). (auth)

6981 DEVELOPMENT TENDENCIES IN THE THEORY OF SIMPLE LANGMUIR PROBES. Wilhelm, J. (Institut fuer Gasentladungsphysik, Greifswald, Ger.). Monatsber. Deut. Akad. Wiss. Berlin, 10: 362-73(1968). (In German).

Advancements and development tendencies in the theory of probes are reflected in the type and manner of solution of the basic problem. A bibliographic review is given of the development of the theory beginning with the Langmuir and Mott-Smith model of 1924. The more common models are briefly described in the historical development. (J.S.R.)

6982 DETERMINATION OF ELECTRONIC TEMPERATURE OF DEUTERIUM PLASMA. Baconnet, J.-P.; Bernard, A.; Cesari, G.; Gourod, M.-S.; Watteau, J.-P. (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). Rev. Int. Hautes Temp. Refract., 5: 147-54(July-Sept. 1986). (In French).

The electronic temperature of deuterium plasma is determined by measuring the relationship between the intensity of the second Balmer line ($D\beta$) and the intensity of a 10-Å band of continuous radiation in ionized deuterium. Theoretical and experimental techniques are described. (auth)

6983 STUDY ON PROBE MEASUREMENTS OF FLOWING PARTIALLY IONIZED HIGH-DENSITY GASES. Kimura, Itsuro; Negishi, Nobuyuki (Tokyo Univ.). J. Fac. Eng., Univ. Tokyo, Ser. B, 29: 261-78(Sept. 1968).

A calculating method applicable to probe measurements (by stagnation-point electrostatic probes) in flowing partially ionized high-density gases (monatomic) is described for the case where (Debye length) $\lesssim$ (mean free path) $\ll$ (boundary layer thickness), and next, the validity of the method is investigated, comparing the probe characteristics obtained by an actual measurement made in partially ionized atmospheric-pressure argon, of which thermodynamic and flowing conditions are known, with the corresponding probe characteristics calculated by the method. As the result of this investigation, it is shown that, for partially ionized argon of the pressure of the order of 1 atm, it is possible to evaluate the approximate value of number density of charged particles in the free stream and that of plasma potential, although the accuracy of the evaluated value of number density or plasma potential is limited by some causes. (NSA of Japan)

6984 PROBE NOISE IN QUIESCENT PLASMAS. Ikezi, Hiroyuki; Fujiwara, Masami; Takayama, Kazuo (Nagoya Univ., Japan). J. Phys. Soc. Jap., 25: 1663-71(Dec. 1968).

The probe noise in quiescent plasmas has been studied experimentally. The observing frequency f normalized to the electron plasma frequency f_{pe} is between 10^{-3} and 1. In the low-frequency range, $f/f_{pe} \ll 1$, the probe noise consists of the shot noise for the electron-collecting region of the Langmuir probe, even when the probe potential is higher than the space potential. The shot noise arising from the probe electron current suffers a reduction due to the transit time effect near the electron plasma frequency. In this frequency range the thermal noise is observed instead of the shot noise. Resonant increases of the noise current are found at the sheath-plasma resonance and at the plasma-wave resonance frequencies. On the other hand, the noise current arising from the probe ion current is smaller than the full shot noise level. The reduction factor for the noise is found to depend on f/f_{pi}, where f_{pi} is the ion plasma frequency. A mechanism for the reduction of the ion shot noise is proposed. (auth)

6985 ENHANCED MICROWAVE SCATTERING BY PLASMA INSTABILITY IN A MAGNETIC FIELD. Kubo, Uichi (Kinki Univ., Osaka); Inuishi, Yoshio. J. Phys. Soc. Jap., 25: 1688-93(Dec. 1968).

The characteristics of microwaves transmitted through dis-

charged cylindrical plasmas in a magnetic field were studied experimentally with a microwave interferometer (35 GHz) which employed a horn antenna system, in order to clarify the effect of the plasma instability on the microwave attenuation. The enhanced attenuation occurred when E field of the wave is parallel to the magnetic field (B), and not in the case of $E_{\perp}$ B. Moreover, in order to investigate the mechanism of this enhanced attenuation, the microwave scattering by the plasma was measured with a microwave interferometer which employed the pickup horns placed at several angles with respect to the axis of radiating horn ($E_{\parallel}$ B). The present experimental results show that, in the turbulent plasma, the enhanced microwave attenuation is due to the scattering by plasma. The scattering is caused by the turbulence in plasma in the presence of a magnetic field. (auth)

Kinetics

Refer also to abstracts 6884 and 7068.

6986 (CEA-tr-R-1939) OSCILLATOR FORCES AND PROFILES OF THE SPECTRAL LINES OF CESIUM IN A PLASMA. Gridneva, S. M.; Kasabov, G. A. Translated into French from 7th International Conference on Phenomena in Ionized Gases, Belgrade, August 22–27, 1965. 13p. (In French). (CONF-650806-27). Dep.

Measurements were made of the absolute oscillator strengths from the spectral lines of cesium in an argon–cesium mixture in a positive column discharge. The results show a broadening and displacement of the spectra lines. They show good comparison with theoretical results. (tr-auth)

6987 (IPP-6/65) SOLUTION OF THE LINEAR PORTION OF DUPREE'S PERTURBATION THEORY FOR PLASMA TURBULENCE. Gratzl, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Mar. 1968. 30p. Dep.

For a turbulent plasma Dupree has given equations somewhat different from the quasi-linear equations, using particle orbits perturbed by the fields for integration. Special assumptions about the solution are made by Dupree for his explicit kinetic equations. In the case of a small diffusion coefficient these assumptions are unnecessary and, in general, one of them even has to be abandoned if energy conservation is to be valid. The differences to the quasi-linear equations are in terms that are nonlinear in the field energy. But in the case of a very large diffusion coefficient, first considered by Dupree, a good approximate expansion is no longer obtained, if the time variation of the distribution function is taken into account. As Orzag and Kraichman have explained, the terms containing initial values can be added. In the case of small diffusion it is shown here that these terms yield familiar results without the secularities of other methods. (auth)

6988 (NP-17701) PLASMA RADIATION MECHANISM IN ASTROPHYSICS. Preprint No. 65. Kaplan, S. A.; Tsytovich, V. N. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1968. 90p. (In Russian). Dep.

Chapters 1, 2, and 4 are devoted to the theory of plasma radiation mechanisms and classification of plasma mechanisms by emission frequencies. Chapters 3 and 5–11 discuss various aspects of the conversion of plasma waves into electromagnetic waves during: (1) scattering on thermal ions and electrons in isotropic plasma; (2) scattering on epithermal nonrelativistic ions and relativistic electrons; (3) Compton scattering; (4) nonlinear scattering on relativistic ions; and (5) scattering on epithermal and relativistic ions. The last and twelfth chapter treats plasma radio-emission mechanisms in radioastronomy. 25 references. (R.V.J.)

6989 (NP-17705) ELECTROMAGNETIC PROPERTIES OF TURBULENT PLASMA. Preprint No. 110. Tsytovich, V. N. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1968. 99p. (In Russian). Dep.

The main problem of the theoretical study of the electromagnetic properties of turbulent plasma lies in the calculation of the tensor of dielectric penetrability of the system, depending on the frequency and wave number of the perturbing electromagnetic field. Current approaches of investigation in this area are reviewed, considering not only specific concrete applications, such as drift instability, but also overall theoretical aspects of the problem, beyond the usual assumption of a weak action of the turbulence on the electromagnetic properties of the plasma. It is pointed out that plasmas encountered in nature, such as cosmic plasma, are usually turbulent; their study may throw some light on the origin of magnetic fields in the Universe. The conclusions reached are expected to be of interest not only for the study of the passage of weak electromagnetic waves through cosmic plasma but also for developing new diagnostic methods for instabilities. (Review article, 55 references). (TTT)

6990 POSITIVE COLUMN IN NEON–HELIUM MIXTURES IN THE REGION OF THE PUPP CRITICAL CURRENT. Sabadil, Heinz; Schwedt, Jochen (Ernst-Moritz-Arndt-Univ., Greifswald, Ger.). Beitr. Plasmaphys., 8: 21-30(1968). (In German).

In the pressure region from 10 to 200 torr, the total current intensities for moving layers were determined in dependence on the gas pressure p and mixing ratio (He/Ne) at various discharge tube diameters. It is shown that the upper limiting pressure for the formation of moving layers in He–Ne discharges in equal fractions of the gas components is essentially below that in the corresponding pure gases. In the region of the upper limiting pressure, the measurement results in the He–Ne discharges are not comparable with the similarity relation valid in pure Ne. For the dependence of the maximum upper limiting pressure on the tube radius, a simple analytical expression is derived in which there are coefficients dependent on the mixing ratio (He/Ne). Its maximum value is at 92% He. The results of the calculations of the gradients, electron energy, and the charge-carrier concentration are reported as functions of the mixing ratio for a special discharge case. (tr-auth)

6991 INVESTIGATIONS ON THE DYNAMIC BEHAVIOR OF GLOW DISCHARGES. Deutsch, H. (Ernst-Moritz-Arndt-Univ., Greifswald, Ger.). Beitr. Plasmaphys., 8: 31-41(1968). (In German).

Impedance measurements were made on glow discharges with distinct positive column in a current and pressure range from 0.6 to 2.5 mA and from 1.35 to 2.6 torr. It was part of an irradiation research to detect the effect of the step ionization on the impedance behavior of discharges. The relation between irregularities in the pattern of the impedance curve and the excitation of the externally excited moving layer are indicated. On the basis of theoretical consideration and the present experimental results it is assumed that the impedance behavior of the positive column at low frequencies can be attributed to a phase displacement of 180° between the magnitude of fluctuation of the field intensity and the electron concentration. (tr-auth)

6992 DETERMINATION OF THE ELECTRIC AND THERMAL CONDUCTIVITY AND THE EFFECTIVE VOLUME BEAM DENSITY FOR AN OXYGEN PLASMA. Neumann, W.; Sacklowski, U. (Physikalisch-Technische Institut, Berlin). Beitr. Plasmaphys., 8: 57-72(1968). (In German).

The radial temperature distribution, the electrical longitudinal field intensity, and the radiation output per cm arc length were measured for an oxygen plasma which was excited in a disc-stabilized arc arangement with 7-mm tube diameter at atmospheric pressure in the current intensity range from 5 to 200 A. From the parameters, the electrical and thermal conductivity and the effective volume beam density are calculated for the temperature region from 8,400 to 12,700°K. The experimentally determined conductivity values were compared with the calculated values. (tr-auth)

6993 EXPERIMENTAL RESULTS OF INVESTIGATIONS OF POSITIVE COLUMNS IN RARE GAS MEDIUM-PRESSURE DISCHARGES. Pfau, S.; Rutscher, A. (Ernst-Moritz-Arndt-Univ., Greifswald, Ger.). Beitr. Plasmaphys., 8: 73-84(1968). (In German).

Experimental results are reported which were obtained in the study of the positive column in rare gas discharges at medium pressure ($p_0 \approx 10$ to 700 torr) and low current intensities ($I \lesssim 10^{-1}$ A). In addition to a review on the various forms of the medium-pressure column, systematic data on the magnitudes of the axial field intensity and the properties of the continua emitted are given. In contrast to previous measurements, the dependence of the continuum intensity on the external parameters (p_0,I,r_0) is described for all rare gases by a simple empirical regularity. (tr-auth)

6994 DIFFUSION THEORY OF POSITIVE COLUMN LOW-CURRENT RARE GAS DISCHARGES AT MEDIUM PRESSURE. Pfau, S.; Rutscher, A. (Ernst-Moritz-Arndt-Univ., Greifswald, Ger.). Beitr. Plasmaphys., 8: 85-100(1968). (In German).

The characteristic parameters of the column plasma in low-current discharges at medium pressure were determined on neon as an example on the basis of the Schottky diffusion theory with application of scattering processes and with consideration of the deviation from quasi neutrality. The calculations are based on an energy distribution of the electron which is given through solution of the Boltzmann equation. The experimental results reported previously were compared with the theoretically obtained column parameters. A satisfactory agreement was found between theory and experiment. The various origin mechanisms of the continuum radiation typical for the rare gas discharges at medium pressure were discussed. The continuum for the visible region can be unrestricted through slowing down of the electrons on the neutral particles. (tr-auth)

6995 INVESTIGATION OF A DISK-STABILIZED LOW-PRESSURE ARC. Krysmanski, Kurt-Herbert; Berndt, Uwe (Ernst-Moritz-Arndt-Univ., Greifswald, Ger.). Beitr. Plasmaphys., 8: 101-8(1968). (In German).

The structure and operational properties of a disk-stabilized arc burning in a sealed vessel for studies in the low-pressure region (principal gas is air, pressure from 5 to 700 torr, iron electrodes, and current density from 2 to 8 A) are described. By spectroscopic measurements, the term population of the iron under various operating conditions of the arc was investigated, with respect to the deviations from a Boltzmann distribution. (tr-auth)

6996 IONIZATION-CONDITIONED COLUMN CONTRACTION. II. MEDIUM-PRESSURE COLUMN WITH INHOMOGENEOUS ELECTRON TEMPERATURE. Wojaczek, Karl (Physikalisch-Technisches Institut, Berlin). Beitr. Plasmaphys., 8: 109-15(1968). (In German).

On the basis of model calculations, oriented to the example of the argon discharge, it is shown that the radial inhomogeneity of the electron temperature in the medium-pressure discharge at higher pressure and current intensities can play a significant role in the discharge mechanism, but that it possesses no essential significance for the relatively highly contracted discharge column. (tr-auth)

6997 CALCULATION OF THE FIELD STRENGTH IN A CURRENT-CARRYING CYLINDRICAL DISCHARGE PLASMA. Franck, G.; Heisen, A. (Univ., Munich). Beitr. Plasmaphys., 8: 117-27(1968). (In German).

A method is presented to evaluate the electrical field in a cylindrical low-pressure discharge plasma within a consistent quasi-neutral model. In comparison with a nonquasi-neutral model the limits of applying a quasi-neutral model are fixed. An iteration procedure is given to evaluate the electrical field for cylindrical plasmas of finite length. The procedure is applied on special models. Results show that for vessels with insulating walls the radial currents generally don't run ambipolar from the axis to the walls. The deviation from ambipolar running can be determined quantitatively. (auth)

6998 ENERGETIC CONDITIONS IN PLASMA OF UNIPOLAR HIGH-FREQUENCY DISCHARGES. Farsky, V.; Janca, J. (Univ., Brno). Beitr. Plasmaphys., 8: 129-42(1968). (In German).

A method and equipment for measurements of the total hf discharge power and its thermal power is presented. The measured difference of both powers is subjected to a theoretical analysis. Experimentally ascertained dependences are in good agreement with values, following from the theory. In molecular gases the supplied hf power is almost totally changed into thermal power. In monatomic gases, in the contrary, the most part of the supplied power is changed into a form of electromagnetic emission irradiated from the plasma. (auth)

6999 CONVECTIVE HEAT TRANSFER IN A LAMINAR NITROGEN PLASMA JET. I. Rother, Wolfgang; Smoljakov, Vadim; Weiss, Karl-Heinz (Technische Hochschule, Ilmenau, Ger.). Beitr. Plasmaphys., 8: 145-55(1968). (In German).

Both from the standpoint of basic research and with respect to numerous technical applications, there is much interest in the detailed data on the heat transfer of flowing plasmas on walls or bodies with plasma flowing around. For the determination of the heat transfer numbers on spherical bodies, measurement methods were developed. Measurement results in the temperature range from 1000 to 4500°K and at a beam velocity interval from 5 to 110 m/sec are reported. (tr-auth)

7000 CONVECTIVE HEAT TRANSFER IN A LAMINAR NITROGEN PLASMA JET. II. Rother, Wolfgang (Technische Hochschule, Ilmenau, Ger.). Beitr. Plasmaphys., 8: 157-65 (1968). (In German).

In Part I measurements on a laminar nitrogen plasma beam were reported. These measurements were used for the determination of temperature, flow velocity, and heat convection density as a function of the site in the beam. The second part is concerned with the theoretical treatment of the heat transfer by forced convection on a sphere in the flowing plasma. It can be shown that the formula given by Sibulkin agrees very well with the measurements up to approximately 4000°K. The formula derived by Fay with consideration of dissociation can first be used from 5000°K. (tr-auth)

7001 TENSORIAL SURFACE HARMONICS DEVELOPMENT IN THE BOLTZMANN EQUATION FOR THE LORENTZ PLASMA OR GAS. Wilhelm, J.; Winkler, R. (Institut fuer Gasentladungsphysik, Greifswald, Ger.). Beitr. Plasmaphys., 8: 167-88(1968). (In German).

For a Lorentz plasma or gas, the Boltzmann second collision integral for short-range interactions was developed explicitly for elastic and inelastic collisions of the first and second type between electrons and neutral particles with application of a tensorial development of the velocity space-solid angle part of the electron single-particle distribution function. The development was made according to the integral symmetrical and irreducible tensors of increasing number of stages built from the velocity unit vector exactly up to first-power terms in the mass ratio of electrons and neutral particles. Together with an analogous development obtained by Johnston of the collision-free Boltzmann equation, the tensorial development of the integral electron Boltzmann equation was obtained for the Lorentz plasma and a tensor-differential equation hierarchy was derived as the defining equation system for the tensorial development coefficients of the electron distribution function. In the breaking down of the hierarchy with the third equation and in sole consideration of the lowest-order noncompensated terms in the mass ratio, a defining equation system already often used in works on Lorentz plasmas results. Further, the method for the derivation of higher orders explains the development of the collision integrals according to the mass ratio and the connection of the macroscopically significant distribution function moments with the tensorial development coefficients. (tr-auth)

7002 PLASMA EXPANSION IN AN INDUCTIVE RADIO-FREQUENCY DISCHARGE. Waidmann, G. (Kernforschungsanlage, Juelich, Ger.). Z. Phys., 218: 298-307(1969). (In German).

The expansion of plasma in the early stage of an inductive high-frequency discharge in helium was investigated experimentally. In a collision-dominated case a nonstationary ambipolar diffusion current transfers a lightly ionized plasma from a source region into an initially neutral ambient gas. Time-resolved measurements of electron density and electron temperature were performed at the source and at a test point outside of the plasma source region by 4-mm microwave interferometer and pulsed double-probe techniques. A comparison of experimental data with calculations based on a simplified diffusion model for collision-dominated plasma expansion is given. (auth)

7003 A STUDY OF BEAM–PLASMA DISCHARGE. PART I. Hasegawa, A.; Yatsui, K. (Osaka Univ.). Kakuyugo-Kenkyu, 21: 377-95(Nov. 1968). (In Japanese).

Characteristics of hot electron plasmas produced by beam–plasma discharge are investigated both experimentally and theoretically. The experimental results on excited waves, self-sustained conditions, the hot electron production mechanism, and diffusion precession of charged particles are compared with theoretical predictions. Ion plasma waves are found to be excited due to a coupling with slow cyclotron waves of the electron beam. Electron hybrid wave interaction with beam slow waves becomes essential in its burnout state. Self-sustained conditions of this discharge are determined in its parameter space. Production mechanism of hot electrons is examined from energy measurement of radiated x rays, which gives a possible evidence of electron cyclotron heating in this rf discharge. Diffusion of charged particles (cold electrons) obeys ambipolar theory in the quiescent plasma state, but in turbulent plasmas diffusion tends to occur with large diffusion coefficients beyond classical values, presumably due to the anomalous enhancement of apparent collision frequencies. (NSA of Japan)

7004 WAVE PROPAGATION ON A MOVING PLASMA COLUMN. Yeh, C. (Univ. of California, Los Angeles). J. Appl. Phys., 39: 6112-13(Dec. 1968).

The results are presented for a study of the propagation of surface electromagnetic waves along a moving plasma column. (M.O.W.)

7005 NUMERICAL AND ASYMPTOTIC SOLUTIONS OF THE DISPERSION EQUATION FOR DIPOLAR SURFACE WAVES ALONG A MAGNETOPLASMA COLUMN. Yip, G. L. (McGill Univ., Montreal); Seshadri, S. R.; Yen, J. L. J. Appl. Phys., 39: 6100-2(Dec. 1968).

Previous investigations of the characteristics of the dipolar surface waves on a magnetized plasma column are extended and completed. In particular, a complete numerical solution of the dispersion equation of the dipolar surface waves, as well as an asymptotic solution valid for large values of the propagation coefficient, have been obtained. Some special features of the dispersion characteristics of the dipolar surface waves are also pointed out. (M.O.W.)

7006 PHENOMENA DURING PLASMA DECAY IN HELIUM AND ARGON AT AN ELEVATED PRESSURE WITH A CESIUM VAPOR IMPURITY AND IN PURE CESIUM VAPORS. Polushkin,

I. N.; Lukashenko, V. I. (Kiev State Univ.). Ukr. Fiz. Zh., 13: 1586-95(Oct. 1968). (In Russian).

Experimental investigations of the process of discharge plasma decay were carried out to study the physical properties of binary plasma in inert gases at elevated pressures with an impurity of alkaline metal vapors. Measurements were made in experimental apparatus at an inert gas pressure of 60-mm Hg and a cesium vapor pressure of 0.1- and 0.4-mm Hg. Charge concentration was changed in the range of 2×10^{15} to 3×10^{15} cm^{-3} and electron temperature from 3200 to 1500°K. At the initial stages of the decay process at $T_e > 2000$°K and $n_e > 10^{14}$ cm^{-3}, the process is quasi-steady-state. Under these conditions, the connection between T_e and n_e is determined by the Saha equation. The quasi-steady-state character of the decay process is broken at the final stages with a decrease of the concentration n_e to $1-5 \times 10^{14}$ cm^{-3} (depending on the kind and pressure of the inert gas). Under these conditions, the decay rate is determined by the recombination velocity. The electron gas cooling rate is determined by degradation of electrons at their elastic collisions with the ions and atoms of the inert gas and alkaline impurity. (auth)

7007 NONLINEAR INTERACTION OF CYCLOTRON HARMONIC WAVES. Harker, K. J.; Crawford, E. W. (Stanford Univ., Calif.). J. Appl. Phys., 39: 5959-68(Dec. 1968).

An analysis is presented of nonlinear interaction between cyclotron harmonic waves propagating perpendicular to the static magnetic field in a warm magnetoplasma. It is demonstrated that the synchronism conditions for traveling wave parametric amplification, and passive mode conversion can easily be satisfied for such waves, and an analysis is carried out for a large-signal pump wave interacting with two small-signal waves. The theory employs the Vlasov equation and Maxwell's equations, and provides expressions suitable for numerical computation. Growth rates and corresponding pump powers are computed, and it is concluded that the effect should be observable in typical laboratory plasmas. A discussion of possible device applications is given. (auth)

7008 EXPERIMENTAL STUDIES OF THE HARMONIC RADIATION IN A MICROWAVE GAS DISCHARGE AT 34 GHz FREQUENCY. Tamaru, Takeshi; Chiyoda, Katsuji; Maejima, Yoshiki (Electrotechnical Lab., Tokyo). Jap. J. Appl. Phys., 8: 104-7 (Jan. 1969).

Experimental studies are made of the harmonic generation in a microwave gas discharge at 34 GHz in pure gases and mixtured ones with air. The result shows that the rare gases do not give effective results compared with air and that these gases mixed with air give promising efficiencies for an application of this phenomenon to a power source. (auth)

7009 OBSERVATIONS OF THE FLOW IN AN ELECTROMAGNETIC SHOCK TUBE. Pert, G. J. (Univ. of Alberta, Edmonton). J. Appl. Phys., 39: 5932-5(Dec. 1968).

Observations of the flow of plasma in an electromagnetic shock tube are presented. Three regimes of flow are found in hydrogen. At high initial gas pressure (>1 torr) and low speeds (<2 cm/μsec) a cold shock-heated region of gas followed by hot turbulent expanding driver gas was found. At low initial gas pressure (<0.5 torr) and high speeds (>4 cm/μsec) a single hot turbulent body of gas moved down the tube. An intermediate flow was found in the intermediate pressure–speed regime. The onset of turbulence in the flow was found to be described by the hydrodynamic Reynolds number. (auth)

7010 RESONANT FREQUENCIES AND FIELDS IN A CAVITY CONTAINING A MAGNETOPLASMA DIELECTRIC. Kent, Gordon (Syracuse Univ., N. Y.). J. Appl. Phys., 39: 5919-27(Dec. 1968).

The problem of a microwave cavity filled with a uniform, cold magnetoplasma is solved exactly. The results are a set of three nonlinear simultaneous equations for the frequency and two spatial parameters. Explicit expressions for all field components for oscillations of a circular cylindrical cavity are given. Numerical results are given showing frequencies and spatial parameters of eight resonant modes in a particular cavity with the cyclotron frequency equal to the unloaded TE_{111} frequency. Four of the modes correspond to the TE_{111} resonance and four correspond to the TM_{111} resonance. In addition, there is a plasma type of resonance at a frequency below the plasma frequency and below the whistler resonance. (auth)

7011 DECAY OF RESONANCE RADIATION IN A PLANAR AFTERGLOW WITH REFLECTING WALLS. Ingold, J. H. (General Electric Lighting Research Lab., Cleveland). J. Appl. Phys., 39: 5834-7(Dec. 1968).

The decay time of Doppler-broadened resonance radiation in a planar afterglow is calculated numerically and compared with the analytic approximation of Holstein. This comparison shows that Holstein's results are higher than the numerical results by as much as 18%, depending on the optical thickness. In addition, the effect of diffusely reflecting walls on the decay time is calculated numerically and compared with the analytic approximation of Weinstein where possible. The numerical results are rigorously valid in the optically thick limit and approximately valid in the optically thin limit. (auth)

7012 POWER FLOW IN PLASMA-FILLED WAVEGUIDES. II. Bevc, Vladislav (Aerospace Corp., Los Angeles). J. Appl. Phys., 39: 5897-5902(Dec. 1968).

Power flow in cyclotron and plasma modes propagating in a waveguide filled with a cold collisionless axially magnetized plasma studied in an earlier paper is reexamined. It is shown that proper evaluation of field expressions at special points on the Brillouin diagram removes difficulties contained in the earlier presentation. Comparison of suitably normalized total power flow as a function of the propagation constants for various representative examples of mode types is made. Interaction or coupling impedances relating transverse and longitudinal electric fields to power flow are calculated. (auth)

7013 ELECTROSTATIC WAVES IN INHOMOGENEOUS AND MAGNETIZED PLASMAS. Lee, Kai Fong (National Center for Atmospheric Research, Boulder, Colo.). J. Appl. Phys., 39: 5902-7(Dec. 1968).

A formalism is presented for the study of electrostatic waves in inhomogeneous plasmas immersed in a finite magnetic field perpendicular to the direction of inhomogeneity. Based on the quasi-static approximation, the dispersion relation is found to depend on the geometrical factors through four quantities which possess certain general properties. The dispersion relation is solved explicitly for the case of cold plasma. It is found that, in stationary plasmas, the density inhomogeneity not only affects the frequencies of oscillation but also alters the propagation and evanescent bands of the two branches of electron plasma waves. For streaming plasmas, the inhomogeneity, the transverse boundary, and the finite magnetic field all contribute to the stabilization of the instability. It is shown that the concept of effective density, developed previously for the infinite magnetic field case, can be extended to the case of finite magnetic field. Various special cases studied previously are recovered by putting appropriate parameters to zero in this general formalism. (auth)

7014 DIPOLE MODES AND THE ONE-WAVE APPROXIMATION FOR TRAPPED MODES IN MAGNETOPLASMA CYLINDERS. Weil, A. J.; Klevans, E. H. (Pennsylvania State Univ., University Park). J. Appl. Phys., 39: 5828-33(Dec. 1968).

An analysis of trapped mode wave propagation is given for a cold, uniform magnetoplasma cylinder embedded in free space. The full set of Maxwell's equations is used and an arbitrary magnetic field strength is allowed. New simplified forms are obtained for the dispersion relation and the fields. The simplified expressions are used to study the dipole modes in detail. Computer solutions are given for the dispersion relation and for the longitudinal fields when the cyclotron frequency is above and below the plasma frequency and for two different column diameters. The fields solutions are sums of terms with two different propagation constants. For the circularly symmetric and dipole modes, it is found that one wave dominates. This has led to a new approximation, the "one-wave" approximation, which gives dispersion curves accurate to within 1% except for the lowest-order dipole mode. (auth)

7015 INVESTIGATION OF THE CONCENTRATION DEPENDENCE OF METASTABLE HELIUM AND NEON ATOMS ON THE PARAMETERS OF A HOLLOW CATHODE DISCHARGE. Znamenskii, V. B. Opt. Spectrosc. (USSR) (Engl. Transl.), 25: 7-10(July 1968).

Translated from Opt. Spektrosk., 25: 17-23(July 1968).

The concentrations of helium atoms at the $1s2s^1S_0$ and $1s2s^3S_1$ levels and neon atoms at the $2p^53sX$ level were measured in a mixture of these gases by the absorption method in 0.85, 1.2, and 2.0-cm diameter hollow-cathode discharges. The concentration vs discharge parameter curves obtained are discussed with regard to the calculated population of these levels. It was found that the measured concentration values of the metastable atoms are inversely proportional to the cathode diameter. (auth)

7016 OCCURRENCE OF STRONG DISCONTINUITIES IN A PLASMA MOVING IN A MAGNETIC FIELD. Gurevich, A. V. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 8: 115-18(Aug. 20, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 193-6(Aug. 20, 1968).

The nonlinear drift properties of quasi-neutral inhomogeneities

of electron and ion density in a plasma situated in a magnetic field are discussed. (M.O.W.)

7017 EFFECT OF THE PLASMA IMPEDANCE ON THE TIME VARIATION OF THE INVERSE PINCH. Sakurai, Takeo (Kyoto Univ.). J. Phys. Soc. Jap., 25: 1671-9(Dec. 1968).

The effect of the plasma impedance in the problem of the inverse pinch is investigated. The initial-value problem is formulated with respect to the electric current and the magnetic cavity radius in the framework of reasonable approximations. Especially, there need be no assumption about the time variation of the electric current. The solution is obtained numerically by the usual method of quadrature, while the initial period of time is examined analytically. The asymptotic approach to the final equilibrium state is investigated by the PLK method of approximation. Representative cases are investigated in detail and it is shown that the duration time of the transient variation is very long in comparison with the operation time of the ordinary intermittent-type MHD devices. (auth)

7018 PLASMA OSCILLATIONS EXCITED BY A FAST ELECTRON IN A METALLIC PARTICLE. Fujimoto, Fuminori; Komaki, Ken-ichiro (Tokyo Univ.). J. Phys. Soc. Jap., 25: 1679-87(Dec. 1968).

The interactions between a fast incident electron and a metallic spherical particle full of a free electron gas as the conduction electrons are studied, using the hydrodynamic equations of Bloch. The obtained energy spectrum of a transmitted electron is composed of the well-known peak due to the bulk-plasma oscillations with small corrections and the peak due to the surface-plasma oscillations, which are given by sum of various modes of oscillations with different energies. The energy value of the surface oscillations at maximum intensity increases with increasing particle size and tends to that in the foil case. Numerical examples are given for an aluminum particle coated with aluminum oxide and for colloidal alkali metal in alkali halide. The latter example is compared with experimental observations. The possibility of the plasma radiation is also discussed. The radiated photon energy is the same as that in the Mie scattering from a small particle. Energy spectra, angular distribution, and photon yield are numerically calculated in the case of aluminum. (auth)

7019 POSSIBLE CHARACTERISTICS OF BREMSSTRAHLUNG SOURCES FOR LASER PUMPING OPTICAL QUANTUM GENERATORS. Rozanov, V. B. (Lebedev Inst. of Physics, Moscow). Dokl. Akad. Nauk SSSR, 182: 320-1(Sept. 11, 1968). (In Russian).

The emission spectrum of bremsstrahlung of a gaseous discharge plasma is of interest for pumping an optical generator because such a source may possess a high intensity in the photon-energy range which creates an inversion of the population in the operating laser material while emitting only a small amount of ultraviolet and short-wave radiation. This is due to the close correlation between the absorption and the photon energy ϵ. In the "transparent" range, most of the energy is emitted from the plasma rather than from the surface. Assuming that the volume emission and the Joule heating are equal, the usual magnetohydrodynamic system of equations for a stationary discharge possesses an analytical solution; this makes it possible to correlate the emission spectrum of the discharge with the plasma current, the electric field and the total number of particles. The problem was examined for the case of a coaxial discharge and an ideal gas plasma. In this case the plasma current is not confined, therefore it is possible to generate the surface of the discharge without changing the emission spectrum. (TTT)

7020 ANOMALOUS ABSORPTION OF CYCLOTRON WAVES IN CONFINED PLASMA. Bogdankevich, L. S.; Rukhadze, A. A. Preprint No. 72. Moscow, Lebedev Inst. of Physics, 1968. 19p. (In Russian).

The absorption of electron cyclotron waves in a confined rarefied plasma under the condition that the Larmor frequency of the electron considerably exceeds the plasma frequency was investigated. In an unconfined plasma under such a condition it is unusual for cyclotron waves to be absorbed. In a confined plasma (e.g., plasma-filled waveguide) because of wave interactions within the plasma, wave absorption can usually become quite anomalously large, if the wavelength is of the same order as the plasma dimensions. The coefficient of absorption is an oscillating function of wavelength and dimensions of the system. The cases of high-temperature collisionless plasma and a cold plasma with a large number of collisions were examined. On the basis of the theory developed, recent experiments on absorption of cyclotron waves in confined plasma were considered. (tr-auth)

7021 PRESSURE INCREASE AND THERMAL CONDUCTIVITY IN A CYLINDERICALLY SYMMETRICAL HYDROGEN PLASMA IN AN AXIAL MAGNETIC FIELD WITH REGARD TO THERMAL FORCES. Raeder, J.; Wirtz, S. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Naturforsch., 23a: 1695-1706(Nov. 1968). (In German).

The pressure increase and total thermal conductivity are calculated for an infinitely long hydrogen plasma column in an axial magnetic field. The calculations, which are based on the first and third moments of the Boltzmann equations for atoms, ions and electrons, are carried out under the assumption of local thermal equilibrium. Numerical results are given for magnetic fields up to 150 kG, temperatures to 10^6 °K, and external pressures ranging from 10^3 to 10^5 dyne/cm^2. Comparison of these results with previous calculations, which neglect thermal forces, shows that they cause an increase of pressure also in the completely ionized plasma and therefore modify the thermal conductivity indirectly. (auth)

Production

7022 (CEA-CONF-1010) LASER-PRODUCED PLASMA FROM A LiH SOLID PELLET. Faugeras, P. E.; Mattioli, M.; Papoular, R. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1968]. 8p. (CONF-680616-2). Dep.

From Conference on Fluid and Plasma Dynamics, Los Angeles, Calif.

A high-density plasma is formed by interaction of a Nd laser beam with a LiH pellet electrodynamically suspended in vacuum. The plasma has been studied by means of photomultipliers and charge collectors. Measurements of the light emitted by the plasma have been performed, particular consideration having been given to the effects obtained by varying the laser energy. A comparison with the predictions of the current theory of the laser plasma interaction shows some disagreement, the possible origins of which are discussed. By means of the charge collectors, one was led to the determination of the freely expanding plasma density profile and to an estimation of the initial mean energy per particle; one was led, as well, to an estimation of the extent to which the plasma recombines during expansion. In uniform magnetic field, up to kG, most of the plasma escapes along the field lines; there is some evidence that a dense and warm plasma is radially confined. (auth)

7023 IMPULSIVE PLASMA PRODUCED BY A COAXIAL PLASMA GUN. Hirano, Katsumi; Irisawa, Juichi; Nakano, Yoshiei (Tokyo Inst. of Tech.). Jap. J. Appl. Phys., 8: 108-10(Jan. 1969).

According to spectroscopic observation the following results have been obtained. When the plasma is produced with an oscillatory current, the gun ejects more than two plasma masses successively. Except the first one they consist mainly of impurities. Spectral lines from helium are recognized only in the first mass. When plasma is produced with a single pulsed current produced by a crowbar action, only one plasma is ejected and the succeeding impurity rich plasma masses are almost eliminated. (auth)

7024 CONTRIBUTION TO THE STUDY OF VERY DENSE PLASMAS. Nguyen Van Trong (Compagnie Internationale pour l'Informatique, Yvelines, France). Compt. Rend., Ser. A and B, 267: 612-5(Sept. 23, 1968). (In French).

Very dense plasmas produced by explosions of wires and mercury filaments were studied. Electron densities above 10^{18} electrons/cm^3 were obtained in the fast condensed discharges (F ~ 100 kHz) at average energy (500 J). The results of measurements obtained by different methods were compared. (tr-auth)

Stability

7025 (GA-8669) PLASMA INSTABILITIES IN GULF GENERAL ATOMIC MULTIPOLE DEVICES. Ohkawa, T.; Yoshikawa, M.; Schupp, A. A. (Gulf General Atomic, Inc., San Diego, Calif.). Apr. 29, 1968. Contract AT(04-3)-167. 14p. (CONF-680805-23). Dep. CFSTI.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR.

The plasma instabilities are studied in both the octopole and quadrupole configurations. A typical set of parameters is plasma density 10^{10} cm^{-3}, ion temperature 100 eV, and electron temperature 10 eV. In both devices the difference of the vector potential between the separatrix and the wall or the stability limit corresponds to about five gyroradii for 100-eV hydrogen ions. In the octopole configuration, three types of fluctuations are recognized. The first type of fluctuation has a zero wave number parallel to the magnetic field and propagates along the diamagnetic current

with a wave number comparable to the reciprocal of the ion gyroradius. The amplitude of the potential fluctuation is about 50 mV and increases rapidly as the octopole field is decreased. The fluctuation is suppressed by applying a toroidal field of a few gauss or by lowering the ion temperature. The results of the fluctuation measurement and the transmission experiment agree with the theoretical dispersion relation for drift cyclotron instability. The second type is observed at the plasma density below 3×10^8 cm^{-3} with a toroidal field larger than 40 G. The mode is identified as the electron-driven drift cyclotron instability with finite parallel wave number. The third type is observed in the plasma with a density below 3×10^8 cm^{-3} only when the ion temperature is lowered. A toroidal field of a few gauss suppresses the fluctuation. The amplitude is approximately uniform and no phase shift is observed along the magnetic line of force. This mode is interpreted as the ion-driven instability due to the modulation of the magnetic field along the line of force. Large-amplitude (20%) fluctuations are found inside the stability limit in the quadrupole device. The frequency spectrum is 10 to 500 kHz. The wave number parallel to the magnetic field line is zero. The phase velocity is in the direction of and less than the ion diamagnetic drift velocity. These characteristics are consistent with an interchange instability due to finite gyroradius of ions. The absence of this type of instability in the octopole device is expected from the theory. (auth)

7026 (IPP–6/66) ELECTROSTATIC INSTABILITIES AND THE THREE ADIABATIC INVARIANTS OF CHARGED PARTICLES. Spies, Guenther Otto (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). June 1968. 69p. (In German). Dep.

The theory of adiabatic invariants of charged particles in general electromagnetic fields is developed. The starting point is a theory of nearly periodic, autonomous, canonical systems derived by M. Kruskal (1962). His theory is generalized here so that it can be applied to the time-dependent problem of the motion of a charged particle in an electromagnetic field. By introducing suitable canonical variables, it is then a simple matter to obtain the well-known results and, what is more important, the conditions for the existence of adiabatic invariants of changed particles. It is proved that in a static magnetic field it is generally a necessary condition for constancy of the longitudinal invariant that the zero-order electric field vanish. The stability behavior of general, singly connected equilibrium configurations of collisionless plasmas is investigated. Electromagnetic disturbances are considered which develop with time so slowly that all three adiabatic invariants of the particles can be regarded as constant. An energy principle in which the electrostatic disturbing potential is the only test function is derived. A sufficient stability criterion is given in the form of monotony conditions on the equilibrium distribution functions. This criterion is also sufficient for stability with respect to faster electrostatic disturbances which already violate the third adiabatic invariant. (auth)

Thermonuclear Processes

7027 (UCRL-Trans–10287) OBSERVATION OF NEUTRONS FROM THE ACTION OF A GIANT LASER PULSE FOCUSSED ON THE SURFACE OF LITHIUM DEUTERIDE. Basov, N. G.; Zakharov, S. D.; Kryukov, P. G.; Senatskii, Yu. V.; Chekalin, S. V. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated by J. Bradley for Univ. of California, Lawrence Radiation Lab., Livermore, from Preprint No. 63. 12p. Dep. CFSTI.

The experimental apparatus for producing and detecting the neutrons is described. Preliminary results are described. (M.O.W.)

Shielding

Refer also to abstracts 6307 and 7281.

7028 GAMMA-RAY STREAMING THROUGH MULTIBEND CYLINDRICAL DUCTS. Ohgushi, Akira (Hitachi, Ltd., Kawasaki, Japan); Kitazume, Mitsuyuki. J. Nucl. Sci. Technol. (Tokyo), 5: 559–63(Nov. 1968).

The ray analysis method is applied to the problem of γ-ray streaming through multibend cylindrical ducts. The total path length of a γ-ray photon through the shielding material is determined by calculating one by one the positions of the intersections between the straight line representing the direction of photon travel and the surfaces of the shield or of the wall of the bent duct, as the photon passes from duct into wall and out of wall into duct. Based on this procedure of calculation, two computer programs have been prepared for the estimation of collision-free and total γ-ray doses, as well as single and total scattered γ-ray doses behind a shield with multibend cylindrical duct. The results of calculation with these programs are compared with the experimental values obtained by Shure and Marshall, and fairly good agreement is obtained. (auth)

Solid-State Physics

Refer also to abstracts 6336, 7102, and 7214.

7029 (INR–P–937) ANTIFERROMAGNETIC ORDERING IN URANIUM MONOARSENIDE AND MONOANTIMONIDE. Leciejewicz, J.; Murasik, A.; Troc, R. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 13p. Dep.

It was found by neutron diffraction that the magnetic structure of UAs at 78°K is of the first kind (I–A) with a saturation moment of 1.93 ± 0.05 Bohr magnetons. Between 78 and 4°K, there is a point of a magnetic phase transition. At 4°K, the magnetic unit cell is doubled in one direction with the moments aligned along the tetragonal unique axis. The sequence of ferromagnetic sheets which are perpendicular to the tetragonal axis is in the order + - - +. The magnetic moment at 4°K is 2.20 ± 0.05 μ_B. The magnetic structure of USb both at 4 and 78°K is of the first kind. The values of the saturation magnetic moments at 4 and 78°K are 2.16 ± 0.05 μ_B and 2.08 ± 0.05 μ_B, respectively. (auth)

7030 (LA-tr–68-29) NEUTRON DIFFRACTION INVESTIGATIONS OF HYDROGEN ISOTOPES FROM 4.2 TO 0.91°K. Bulatov, A. S.; Kogan, V. S. Translated by A. D. Cernicek (Los Alamos Scientific Lab., N. Mex.), from Zh. Eksp. Teor. Fiz., 54: 390–4(1968). 12p. Dep. CFSTI.

The crystal structures of normal hydrogen, normal deuterium, and para-hydrogen are studied by observing the diffraction of slow neutrons with wavelengths of 1.277 ± 0.002 A. At temperatures between 4.2 and 0.91°K, para-hydrogen and normal deuterium crystallize into hexagonal close-packed lattices with different unit cells. In the indicated temperature range, normal-composition hydrogen undergoes a phase transition of the first kind. The hexagonal close-packed lattice changes into a face-centered cubic lattice. The phase transition exhibits hysteresis. The transition point upon cooling is found to be 1.46 ± 0.02°K; upon heating, the return to the hexagonal lattice occurs at 1.68 ± 0.02°K. (auth)

7031 (UCRL–50477) MOESSBAUER RECOILLESS FRACTION OF GOLD. Ohlwiler, Robert William (California Univ., Livermore. Lawrence Radiation Lab.). June 1968. Contract W-7405-eng-48. 62p. Dep. CFSTI.

Thesis. Submitted to Univ. of California, Davis.

The Moessbauer recoilless fraction, f, of the 77-keV gamma ray of ^{197}Au in a gold metal absorber has been measured as a function of temperature between 4.5 and 100°K. The source was ^{197}Au in platinum metal. The Moessbauer spectrum was fit with the absorption integral, and the recoilless fraction was derived from the shape and width of the spectrum. The recoilless fraction varies between 0.17 at 4.5°K and 0.01 at 100°K. The analysis indicates that the source and absorber lines are Lorentzian and have approximately equal widths, 0.937 ± 0.011 mm/sec. Shirley's theoretical estimate of the internal conversion coefficient, 3.96 ± 0.14, was assumed in the recoilless fraction calculations. The Debye temperature vs temperature corresponding to the measured recoilless fraction was compared to that derived from theoretical phonon frequency distributions reported in the literature. An appendix gives many general properties of the Moessbauer absorption integral. (auth)

7032 X-RAY-INDUCED ENHANCEMENT EFFECT IN ELECTROLUMINESCENT ZINC SULPHIDES. Singh, V. B.; Mohan, Hari (Univ. of Allahabad, India). Z. Phys., 218: 129–36(1969).

Enhancement effect in electroluminescent emission from ZnS:Cu, Cl and ZnS:Cu, Mn, Cl luminophors under the concurrent action of sinusoidal electric field and x radiation was investigated. Variation of the enhancement ratio $R = (B_{E+R})/(B_E + B_R)$, (where B_{E+R} = light output when both electric field and x radiation are operative; B_E = electroluminescent output; and B_R = photoluminescent output) with frequency and voltage of the applied ac field and with x-ray intensity was studied. A nonlinear behavior of the enhancement with voltage and x-ray intensity was found, similar to that observed in the case of ultraviolet-stimulated electroluminescent emission. R_{max} in both species studied is always found to be less than 4/3 in each case. (auth)

7033 EFFECT OF NEUTRON IRRADIATION ON THE MARTENSITIC TRANSFORMATION IN β_1-COPPER–ZINC. Hummel, R. E.; Koger, J. W. (Univ. of Florida, Gainesville). Phys. Status Solidi, 30: 515–23(Dec. 1, 1968).

Resistivity measurements were used to determine the characteristic properties of the martensitic transformation in β_1-brass (39.4 wt % Zn) before and after neutron irradiation. The doses varied between 5×10^{16} and 5×10^{18} neutrons/cm^2 (E > 1 MeV). Neutron irradiation decreased the martensitic-start temperature (M_s) up to 8°C and increased the maximum rate of transformation. M_s was further decreased when β_1-brass was annealed at 150°C

after irradiation. A small decrease in M_s was observed when unirradiated, quenched β_1-brass was annealed at 150°C. Possible mechanisms which give rise to the inhibition of the martensitic transformation, such as dislocation pinning, are discussed. (auth)

7034 MOESSBAUER EFFECT IN SIMPLE CUBIC LATTICE WITH LINE DEFECT. Cely, J. (Purkyne Univ., Brno). Phys. Status Solidi, 30: 671-83(Dec. 1, 1968).

A theoretical study is made of the Moessbauer effect in simple cubic lattices with a line defect for both the atoms inside and outside the perturbed region. Numerical calculations are made of the changes in the Debye–Waller factor for a special type of defect (with variation of the mass and force constants along a single atomic row in [001] direction) in the classical approximation together with quantum corrections. Two methods, the high-temperature expansion and another one which is valid for arbitrary temperatures, are used. A possibility of using graphs for some estimations, especially for the dependence of the quantum correction on the distance of the absorbing atom from the line defect, is suggested. (auth)

7035 DECHANNELING CYLINDER OF DISLOCATIONS. Quere, Y. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Phys. Status Solidi, 30: 713-22(Dec. 1, 1968).

A particle channeled in a crystal may be dechanneled when passing near a dislocation. This effect is simulated by an opaque cylinder dechanneling any particle hitting it. This cylinder is coaxial to the dislocation and has a diameter $\lambda = (b\ d\ a\ E)/(\alpha\ Z_1\ Z_2\ e^2)^{\frac{1}{2}}$. E is the energy of the particle (charge Z_1 e), b the Burgers vector, d the interatomic distance along the considered channel in the crystal Z_2, a the screening radius, and α a number equal to 12.5 and 4.5 for screw or edge dislocations, respectively. (auth)

7036 EXPERIMENTAL EVIDENCE FOR INTERBAND MIXING IN RARE-EARTH INTERMETALLIC COMPOUNDS. de Wijn, H. W. (Univ., Amsterdam); Buschow, K. H. J.; van Diepen, A. M. Phys. Status Solidi, 30: 759-66(Dec. 1, 1968).

Measurements of the Knight shifts and susceptibilities of rare-earth intermetallic compounds have been extended to YCu, GdCu, TbCu, DyCu, HoCu, and ErCu. The phenomenological exchange constants $\mathfrak{I}_{sf}$ between 4f-electron spins and conduction-electron spins are derived to be 0.21 eV. Also, the paramagnetic Curie temperatures of the compounds $GdCu_{1-x}Ga_x$ have been measured. The Knight shifts and Curie temperatures are discussed in terms of the Ruderman–Kittel–Kasuya–Yosida theory. For the various series of rare-earth intermetallic compounds, the s-f exchange integral $\Gamma = 2\ J(0)$ and the Fermi wave vector k_F have been determined. Γ is found to be a continuous function of k_F, with a sign reversal at $k_F \approx 1.4\ A^{-1}$. This observed behavior is consistent with the calculations of Watson, Koide, Peter, and Freeman on the effect of interband mixing on the exchange interactions. (auth)

7037 CHANGE IN MAGNETIC PROPERTIES OF THIN NICKEL FILMS WHEN IRRADIATED WITH 850-keV PROTONS. Arbuzov, V. L.; Buzynov, A. E.; Dvinyaninov, B. L.; Kikoin, A. K.; Stadukhin, V. M.; Panov, V. A. (Inst. of the Physics of Metals, Moscow). Fiz. Metal. Metalloved., 25: 764-7(1968). (In Russian).

The effect of proton irradiation on the magnetic properties of thin nickel films was studied. The films were made by heating nickel with an electron beam in a 5×10^{-6} torr vacuum and evaporating the metal on a glass substrate heated to 250°C to avoid residual stress. Film thickness ranged from 2000 to 8000 Å. Irradiation was done at about −75°C in a beam of 850-keV protons produced in an electrostatic generator. Magnetic hysteresis loops are shown of one of the nickel films, before and after irradiation. Irradiation was found to decrease the coercive force and increase the residual induction. Both effects were intensified with an increase in the irradiation dosage. At a dose of 10^{19} n-cm^{-2} the coercive force was so small that it could not be measured on the magnetometer used. X-ray analysis showed that irradiation caused a decrease in the (022) line width. The effect of proton irradiation on magnetization curves was different than that obtained for nickel films irradiated with neutrons of the same dosage (Teodoresku and Glodeanu, Phys. Rev. Letters, 4: 231(1960)). There was no tendency for the magnetic properties of proton irradiated nickel films to diminish, and there were no new x-ray lines to indicate a change of structure. These effects were obtained in neutron-irradiated films, as reported by Teodoresku and Glodeanu. It is possible that the decrease in coercive force and increase in residual induction of proton-irradiated samples was caused by residual stresses induced during cooling. To test the effect of residual stress, experiments were conducted on a nickel film applied to a bent tantalum substrate. After evaporation of the nickel the substrate was straightened to induce residual stress. This film had a large amount of magnetic anisotropy. The films made on glass were almost isotropic. The anisotropy largely disappeared after proton irradiation. The coercive force, magnetic induction, and residual induction are presented for easy and hard magnetization directions in the nickel coated tantalum, before and after irradiation. Irradiation was found to be very effective in reducing the residual stress level. (ATD)

7038 MAGNETIC SYMMETRY OF URANIUM COMPOUNDS OF UX_2 TYPE. Przystawa, J. (Wroclaw Univ.). Phys. Status Solidi, 30: K115-17(Dec. 1, 1968).

A description of the magnetic structure of UX_2 and UOX type compounds is given in terms of magnetic space groups (MSG). The A-I type is only ordering invariant with respect to P4/n′m′m′ ($W^{4/m}_{16i} - D^1_{4h}/D^1_4$ in Koptsik's notation), while A-II and A-iII have the same MSG $P_{2c}\ 4/nm'm'$ ($W^{4/m}_{16i} - 2D^1_{4h}/D^2_{4h}$) in common. For the last two, there exists only one ordering invariant with respect to $P_{2c}\ 4/nm'm'$. The effects of magnetic symmetry on properties are discussed. (D.L.C.)

7039 THERMOLUMINESCENCE OF Z_1 CENTERS IN Ca-DOPED KCl CRYSTALS AFTER X IRRADIATION. Berg, K.-J.; Meyer, K.-P. (Martin-Luther Univ., Halle, Ger.). Phys. Status Solidi, 30: K161-4(Dec. 1, 1968).

Thermoluminescence and optical absorption measurements were made on x-irradiated Ca-doped KCl crystals before and after optical bleaching in the F band. The glow curve of an x-irradiated crystal shows a weak peak at 110°C and a stronger one at 170°C; optical bleaching increases the 110°C peak and reduces the 170°C peak. The absorption spectrum shows only the F band at 562 nm, which is broadened and shifted toward longer wavelengths. This effect and the 110°C thermoluminescence peak are attributed to Z_1 centers which are formed by optical bleaching. (D.L.C.)

7040 PARAMAGNETIC RESONANCE OF SILVER ATOMS STABILIZED IN ALKALI METAL HALIDE CRYSTALS. Baranov, P. G.; Zhitnikov, R. A.; Melnikov, N. I. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Status Solidi, 30: 851-8(Dec. 1, 1968).

Stabilized silver atoms are obtained at 77°K by irradiating alkali metal halide crystals (LiCl, NaCl, and KCl) containing silver ions with x rays. The properties of these stabilized atoms are studied by PR (paramagnetic resonance). It is found that the silver atoms occupy the cationic sites of the crystals studied. The dependences of the hyperfine and superhyperfine interaction constants on the lattice constant, i.e., on the distance from the surrounding chlorine ions, are studied. The temperature dependences of the hyperfine and superhyperfine structure constants of silver atoms in the case of LiCl : Ag are also studied. (auth)

7041 ON THE STAGE III RECOVERY OF ELECTRON-IRRADIATED COPPER. Brugiere, R.; Lucasson, P. (Laboratoire de Chimie Physique, Orsay, France). Phys. Status Solidi, 30: K139-43(Dec. 1, 1968).

Pure Cu samples were irradiated at 113°K by 1.56-MeV electrons and then given isochronal or isothermal anneals. In the isochronal anneals, the time was 2.5, 5, or 10 min, and the temperature increase was only 5°. The stage-III recovery was found to be complex, containing four substages. The recovery kinetics were analyzed; the third substage was found to be a second order process with an activation energy of 0.69 ± 0.05 eV, from isothermal anneals. The activation energies of the other substages were also derived. The results are compared with literature and results for Cu irradiated with other particles or cold-worked. It is concluded that the mobile defects involved in stage III of electron-irradiated Cu are identical to these formed by heavy particles or cold-worked. (D.L.C.)

7042 ON THE CRYSTALLINE FIELD SCREENING EFFECTS FOR THE 4f SHELLS OF RARE EARTH IONS AND NUCLEAR MOMENTS. II. Makhanek, A. G.; Korolkov, V. S. Opt. Spectrosc. (USSR) (Engl. Transl.), 25: 53-5(July 1968).

Translated from Opt. Spektrosk., 25: 104-8(July 1968).

Calculations have been carried out for screening constants of the electric field gradients of ligands, produced at the location of the shell distribution of rare earth ions. Slater and hydrogen-like wave functions were employed in the computations. (auth)

7043 INVESTIGATION OF MOLECULES ADSORBED ON SEMICONDUCTORS BOMBARDED BY EXCITED MERCURY ATOMS. Panesh, A. M.; Myasnikov, I. A. Zh. Fiz. Khim., 42: 2100-2(Aug. 1968). (In Russian).

An increased conductivity was observed in a thin film of ZnO on which adsorbed hydrogen was bombarded by excited atoms of mercury. It was shown that this phenomenon results from the dissociation of molecules of hydrogen on atoms on the surface of ZnO. (tr-auth)

7044 ABSORPTION OF IRRADIATED LiF CRYSTALS IN THE ir REGION OF THE SPECTRUM. Akhvlediani, Z. G.; Politov, N. G. Opt. Spectrosc. (USSR) (Engl. Transl.), 25: 86-7(July 1968).

Translated from Opt. Spektrosk., 25: 163-4(July 1968).

LiF crystals were irradiated with either pure gamma or mixed gamma–neutron radiations and its optical properties determined in the 2- to 25-μ region. Maxima at 4.5 and 5 μ and secondary absorption bands appeared, depending on the irradiation conditions and initial dislocation density. Conversion of the two maxima at 4.5 and 5 μ was investigated and found to be possible. Annealing at 250°C removed the ir absorption bands, indicating that the radioinduced defects are thermally unstable. (D.L.C.)

7045 ANISOTROPY OF THE g-TENSOR OF THE Er^{3+} ION IN ERBIUM–GALLIUM GARNET. Belyaeva, A. I.; Eremenko, V. V.; Pavlov, V. N.; Antonov, A. V. Opt. Spectrosc. (USSR) (Engl. Transl.), 25: 55-7(July 1968).

Translated from Opt. Spektrosk., 25: 109-12(July 1968).

As an example of the transition $^4I_{15/2} \rightarrow {}^4S_{3/2}$, the anisotropy of the g-tensor of the Er^{3+} ion was investigated in ErGaG with the aid of a study of the Zeeman effect. The principal values of the g-tensor in the ground and excited states were found. (auth)

7046 LOW-TEMPERATURE RADIOCRYSTALLOGRAPHIC STUDY OF THE MAGNETIC TRANSITION OF THE URANIUM OXIDE UO_2. de Kouchkovsky, Rostislav; Lecomte, Marcel (CEA, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 267: 620-2(Sept. 23, 1968). (In French).

The x-ray diffraction study of the oxide UO_2 shows that the para-antiferromagnetic transition in this compound near 31°K is accompanied, from the crystallographic viewpoint, by a volume discontinuity alone, the symmetry remaining cubic. The transformation is reversible and is not affected by a slight deviation to stoichiometry. (tr-auth)

7047 MOESSBAUER EFFECT IN $(Zr_xNb_{1-x})Fe_2$. Tanaka, Midori; Iio, Naoko; Tokoro, Tetsuji (Ochanomizu Univ., Tokyo). J. Phys. Soc. Jap., 25: 1541-3(Dec. 1968).

The Moessbauer technique was employed to study the magnetism of Laves phase compounds, $(Zr_xNb_{1-x})Fe_2$. Hyperfine field strengths were about 200 kOe in the ferromagnetic compounds and very small value or zero in the antiferromagnetic compounds. The values of the quadrupole coupling constant were slightly different between cubic (ferromagnetic compound) and hexagonal phases (antiferromagnetic compound). Isomer shifts were almost constant over all composition. The magnetic moment for x = 0.6 had an apparent value of 0.42 μ_B. (auth)

7048 DETERMINATION OF THE SURFACE CHARGE OF GERMANIUM ALLOYED WITH RADIOACTIVE ANTIMONY. Spitsyn, V. I.; Gromov, V. V.; Arakelyan, V. S.; Lysenko, N. G. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk. SSSR, 182: 390-3(Sept. 11, 1968). (In Russian).

Decay of a β-active isotope at the surface of a conductive radioactive material creates a stationary charge; in the case of K capture, the charge is positive. It was attempted to calculate and to determine experimentally these charges. For the experimental work 20 × 10 0.3 mm foils of germanium, diffusion-alloyed with ^{124}Sb were used; this isotope has a complex β, γ spectrum. The specific activity of the specimens was between 1.05×10^{-5} to 4.5×10^{-7} Ci/g. As the surface charge was small, the measurements were carried out under a pressure of 2 to 6 mm of Hg, at a precision of about 30%. The calculated and experimental values agreed with each other, confirming the linear dependence of q_p on $Q^{\frac{1}{2}}$, whereby q_p is a stationary charge and Q is the specific activity. The theory indicated that at atmospheric pressure, q_p would be an order of magnitude smaller, i.e., ~0.5 to 5×10^{-16} Coulomb/cm^2. Materials with low conductivity are expected to exhibit to an even greater extent the effect of the emission of charge particles. (TTT)

7049 ANOMALOUS SCATTERING OF SLOW NEUTRONS AND ELECTROMAGNETIC WAVES IN FERROMAGNETS WITH SMALL MAGNETIC ANISOTROPY. Akhiezer, I. A.; Belozorov, D. P. (Kharkov State Univ.). JETP Lett. (USSR) (Engl. Transl.), 8: 128-30(Aug. 20, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 212-16(Aug. 20, 1968).

The observance of critical fluctuations in magnetically ordered crystals near the point at which the magnetic symmetry of the crystal changes is discussed. (M.O.W.)

7050 ELECTRONIC STRUCTURE OF REFRACTORY METALS, COMPOUNDS, AND ALLOYS. Gibbons, D. F. (Case Inst. of Tech., Cleveland). pp 105-19 of Anisotropy in Single-Crystal Refractory Compounds. Vol. 1. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio. See CONF-670637–(Vol.1).

A review is presented of various methods used to calculate the band structure of transition metals and compounds. Data on the metals and alloys of Groups IV and V of the first two transition metal series (particularly Zr and Zr–Nb alloys) are presented and discussed. Progress being made in determining the electronic configuration of molecules is discussed, and the possibility of using the data to gain a better insight into the antiferromagnetic behavior of some of the oxides is considered. (D.L.C.)

7051 NON-STOICHIOMETRY AND BONDING IN REFRACTORY MONOCARBIDES. Hoch, Michael (Univ. of Cincinnati). pp 163-75 of Anisotropy in Single-Crystal Refractory Compounds. Vol. 1. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio. See CONF-670637–(Vol.1).

The refractory monocarbides with the sodium-chloride type structure have a wide homogeneity range. Equations have been derived from statistical considerations to give the activity of each component as a function of composition and temperature based on the interaction energies between the various components. From the activity measurements as a function of composition in various binary carbides and nitrides of the Groups IV and V transition elements and in the ternary Zr–Nb–C system, the various interaction energies were calculated. The metal-to-metal interaction energy is the same in the carbides as it is in the pure metals and metallic solutions; therefore, the metal to metal bonding is the same in pure metals and in the carbides. The high melting point and other refractory properties of the carbide arise from the metal–carbon bond. The metal–carbon bond is stronger in Group IV carbides than in Group V carbides. The metal–carbon bond energy decreases as the atomic weight of the metal increases. The experimental results also indicate that the metal–carbon bond is such that the carbon atom is ionized, the ionization increasing with the bond strength. (auth)

7052 ELECTRONIC STRUCTURE OF TRANSITION CARBIDES AND NITRIDES. Costa, P. (ONERA, Chatillon-sous-Bagneux, France). pp 151-9 of Anisotropy in Single-Crystal Refractory Compounds. Vol. 1. Vahldiek, Fred W.; Mersol, Stanley A. (eds.). New York, Plenum Press, 1968.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio. See CONF-670637–(Vol.1).

Previous publications have suggested that the band structure of the transition carbides and nitrides might be very similar to the band structure of the transition metals with a narrow, predominantly d, band. It is shown how this model can be modified to account for NMR experiments by Rossier. Ionic character and d-p hybridization are discussed. Two other topics are discussed: (1) The existence of ordered structures of interstitial atoms (V_8C_7). (2) The validity of the transition metal model for substoichiometric compounds and with recent experiments on semi-carbides M_2C. (auth)

7053 ENERGY DISTRIBUTION FOR 6.72-MeV PROTONS IN MONOCRYSTALS. Shipatov, E. T.; Kononov, B. A. At. Energ. (USSR), 25: 439-40(Nov. 1968). (In Russian).

Energy distributions of protons with initial energy 6.72 MeV in cubic ion monocrystals (NaCl, KCl, and KBr) and monocrystals Si and Ge were studied in order to determine the channeling of positive charged particles along crystallographic directions and monocrystalline planes. Curves of energy distribution of 6.72-MeV protons passing through a 73-μ-thick NaCl monocrystal was constructed at various angles in relation to the crystallographic plane (100). The energy loss of protons in a noncoherent beam are in good agreement with those calculated using the Bethe–Bloch formula. Graphical data are also given on channeling efficiency as correlated with incoming and reflected angles. Correlations of the widths of angular distribution $\alpha_{\frac{1}{2}}$ with the calculated magnitudes of maximum channeling angles showed that channeled 6.72-MeV protons fit the atomic planes (100) (NaCl, KCl, and Br) and (110) (Si and Ge) within 0.1 Å. (R.V.J.)

7054 MAGNETIC SUSCEPTIBILITY OF PLUTONIUM–PALLADIUM ALLOYS. Chebotarev, N. T.; Sokurskii, Yu. N.; Andrianov, M. A.; Ivanov, A. A. At. Energ. (USSR), 25: 431-3 (Nov. 1968). (In Russian).

A system of Pu and Pd alloys with a wide range (up to ~14 at. %) solid solutions of palladium base and four intermetallic compounds, with three compounds (PuPd, Pu_3Pd, and $PuPd_3$) stable at room temperature were studied. Magnetic susceptibility of solid solution at room temperature and as function of their composition

was tabulated. It was assumed that in PuPd, Pu_3Pd_4, and $PuPd_3$ compounds palladium has a closed d shell and its contribution to the magnetism is related not to d but s electrons. (R.V.J.)

7055 STRUCTURE OF A PuPd COMPOUND. Beznosikova, A. V.; Smotritskaya, E. S.; Chebotarev, N. T. At. Energ. (USSR), 25: 430-1(Nov. 1968). (In Russian).

Structure and composition of Pu_3Pd_4 was studied. Roentgenograms of PuPd single crystals showed that the compound has a rhombic structure. Experimental and theoretical intensity lines for powder roentgenograms are in good agreement. (R.V.J.)

7056 RADIATION ANNEALING AND MODIFICATION OF THE 35° AND 65°K DEFECTS IN GERMANIUM AT LOW TEMPERATURE. DeAngelis, Henry M.; Penczer, Rudolf E. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Appl. Phys., 39: 5842-5(Dec. 1968).

Damage introduced in n-type germanium at ~7°K with 1.0-MeV electrons undergoes radiation annealing and conversion when subjected to 0.5-MeV electron irradiation at ~7°K. The radiation annealing with only 65°K and permanent defects present appears to be a first-order process with an estimated cross section of 10^{-15} cm^2, while radiation annealing with 35°, 65°K, and permanent defects present appears to be a second-order process. It appears that only the 35° and 65°K defects are recovered and 65°K defects are converted to 35°K defects as part of the radiation-annealing process. The radiation anneal of converted damage seems to be the rate-limiting process in the radiation anneal of 65°K defects. The results show evidence for another type of 65°K defect as suggested by Zizine and by Whan's work. If this is the case, then the results imply that this second type is not subject to radiation annealing. (auth)

7057 WORK-FUNCTION MEASUREMENTS ON MONOLAYER FILMS OF URANIUM ON (100), (110), AND (113) ORIENTED FACES OF TUNGSTEN SINGLE CRYSTALS BY PHOTOELECTRIC AND CONTACT POTENTIAL DIFFERENCE TECHNIQUES. Lea, Colin; Mee, C. H. B. (Southampton Univ., Eng.). J. Appl. Phys., 39: 5890-6(Dec. 1968).

Uranium was evaporated on to (100), (110), and (113) oriented faces of tungsten single crystals at pressures of less than 5×10^{-10} torr. The work function of each of the tungsten surfaces was monitored by photoelectric and contact potential difference (Kelvin and electron-beam) techniques as uranium was adsorbed on to it. The curves of work function versus coverage were fitted to the Gyftopoulos and Levine theory of monolayer adsorption. The constants of the curves gave a value for the density of uranium atoms in a monolayer on each tungsten surface: For the (100) surface, one uranium atom is adsorbed for each unit cell in the two-dimensional lattice of surface tungsten atoms; on the (110) surface, there is one uranium atom for every two unit cells; and on the (113) surface, there are four uranium atoms to each unit cell. For film thicknesses of about two monolayers, the photoelectric technique gave work function values in excellent agreement with those from the Kelvin method, the values being 3.73 ± 0.02 eV for the U/W_{100} system, 3.90 ± 0.03 eV for U/W_{110}, and 3.67 ± 0.03 eV for U/W_{113}. The electron-beam values were higher than those obtained by the other two methods, probably due to an increase in the electron reflection coefficient as uranium is adsorbed on to tungsten. (auth)

7058 EMISSION PROCESSES ACCOMPANYING MEGAVOLT ELECTRON IRRADIATION OF DIELECTRICS. Watson, Alan; Dow, Julian (Ion Physics Corp., Burlington, Mass.). J. Appl. Phys., 39: 5935-40(Dec. 1968).

Experiments are described in which thick dielectric samples were irradiated with electrons of about 1-MeV energy. The temporal growth of the external electric field from the trapped charge was punctuated by either total or partial collapses associated with electron emission and followed by pauses before the process repeated itself. Secondary electrons are thought to be heated by the growing internal space charge field until thermionic emission induces a regenerative growth of positive surface charge sufficient to oppose it. Electron emission then ceases until recombination can restore the outside surface of the dielectric to a field-free condition from which it grows again. Analysis of this model shows that it appropriately describes the observed phenomena. (auth)

7059 FORMATION OF $Hg_{1-x}Cd_xTe$ by Hg ION BOMBARDMENT OF CdTe SINGLE CRYSTALS. Foss, Norman A. (CBS Labs., Stamford, Conn.). J. Appl. Phys., 39: 6029-31(Dec. 1968).

Layers of $Hg_{1-x}Cd_xTe$ have been formed by Hg^+ ion bombardment of intrinsic CdTe single crystals. Spectral photoresponse measurements indicate a variation in x through the thickness of the $Hg_{1-x}Cd_xTe$ ranging from $x \simeq 0.2$, at the surface, to $x = 1$ corresponding to a bandgap of 0.12 and 1.5 eV, respectively. The material has a conductivity of typically 10^{-5} $(\Omega \cdot cm)^{-1}$ at 77°K and a 2-μ thickness in the region where $x \leq 0.3$. (auth)

7060 MOESSBAUER EFFECT IN ^{231}Pa. Croft, W. L.; Stone, J. A.; Pillinger, W. L. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. J. Inorg. Nucl. Chem., 30: 3203-8(Dec. 1968).

The Moessbauer effect was observed with the 84.2-keV gamma ray of ^{231}Pa, following beta decay of 25.5-hr ^{231}Th. In experiments at 4.2°K using ThO_2 sources, resonance absorption was detected with absorbers of both $^{231}Pa_2O_5$ and $^{231}PaO_2$. In each case the resonance was broad and unresolved, with the maximum absorption dip ~0.1% (uncorrected for background). The spectra showed no discernible isomer shift between the valence states of protactinium. (auth) (UK)

7061 DIRECT METHOD FOR CALCULATING HIGH-RESOLUTION NUCLEAR MAGNETIC RESONANCE SPECTRA. Binsch, Gerhard (Univ. of Notre Dame, Ind.). Mol. Phys., 15: 469-78(1968). (COO-38-615).

A method for calculating unsaturated slow-passage NMR spectra is presented which differs from conventional procedures in that no energy levels and no wave functions have to be computed and that no explicit line-shape function need be specified. It is shown, by developing the theory in the Liouville representation of quantum mechanics rather than in the Hilbert space representation, that it is possible to compress the total information content of an NMR spectrum into two complex vectors, a radiofrequency-independent "shape vector" and a "spectral vector" which is a trivially simple function of the radiofrequency. The absorption spectrum is obtained as the negative real part of the scalar product of these two vectors. The method may be regarded as an extension of the super-operator formalism of Banwell and Primas. (auth) (UK)

7062 SURFACE DISSOCIATION OF POTASSIUM CHLORIDE BY LOW-ENERGY ELECTRON BOMBARDMENT. Palmberg, P. W.; Rhodin, T. N. (Cornell Univ., Ithaca, N. Y.). J. Phys. Chem. Solids, 29: 1917-24(Nov. 1968).

Surface dissociation of ultrahigh-vacuum-cleaved KCl during low-energy electron irradiation was observed. The method employed mass spectrometer to measure the desorption rate of dissociation products, and Auger electron spectroscopy for the determination of surface composition. The results show that K, Cl, and Cl_2 are desorbed from the surface as neutrals. Above 100°C, desorption of constituents into the vacuum is believed to occur primarily through generation of bulk defects followed by diffusion transport to the surface and, to a lesser extent, through direct dissociation at the surface. Auger electron spectroscopy measurements indicated that surface defects generated by moderate irradiation at room temperature or below are mainly chlorine-ion vacancies. (auth) (UK)

7063 THEORY OF THE OPTICAL AND MAGNETIC PROPERTIES OF A RADIATION-INDUCED MOLECULE-ION IN ALUMINUM OXIDE. Fournier, J. T.; Bartram, R. H. (Univ. of Connecticut, Storrs). J. Phys. Chem. Solids, 29: 2029-41(Nov. 1968).

A theoretical study of the electronic structure of an AlO^{3-} molecule-ion stabilized in a double anion vacancy of the Al_2O_3 lattice was undertaken in an effort to establish quantitative correlations with the magnetic properties of a defect observed in neutron irradiated Al_2O_3. The valence electrons are treated explicitly in the LCAO–MO approximation. An effective one-electron potential is used to approximate electronic interactions, and crystal field effects are described in a point-ion model. Molecular orbital energies and wavefunctions are calculated for a set of internuclear separations in the range 0.74 to 1.0 times the normal anion–anion separation. Over this entire range a $^3\Sigma$ ground term is predicted, a result consistent with the observed spin-resonance spectrum of the defect. In addition, the first-order contribution of spin–spin interaction to the zero-field splitting of the triplet ground term is computed using the calculated MO's. It is found that the predicted zero-field splitting is about thirty times larger than the observed value. This result is attributed to the lack of spatial correlation of the paramagnetic electrons in the MO picture and, from a calculation based on a Heitler–London wave function, it is shown that spatial correlation can result in a zero-field splitting of the magnitude observed. Finally, the hyperfine splitting is computed, and it is shown that the model is consistent with the observed absence of resolved hyperfine structure in the spin-resonance spectrum. (auth) (UK)

7064 MAGNETIZATION AND MAGNETIC SPECIFIC HEAT OF TERBIUM. Brooks, M. S. S.; Goodings, D. A.; Ralph, H. I. (Univ. of Sussex, Brighton, Eng.). J. Phys. C, (London), 1: 1596-1603(Dec. 1968).

Spin-wave theory, renormalized to take account of spin-wave interactions, is used to calculate the temperature and field depen-

dence of the magnetization of terbium and the temperature dependence of the magnetic contribution to the specific heat. The calculations are based on an interpolation scheme for the spin-wave energies as a function of wave vector and of temperature, which gives an approximate fit to the available data obtained by inelastic neutron scattering. Good agreement is found with the magnetization measurements of Hegland, Legvold, and Spedding (1963) up to about 180°K. The question of what is the best expression for the internal energy from which to calculate the magnetic contribution to the specific heat is discussed, and calculations are reported based on an expression proposed by Radcliffe (1968). A crude comparison with experimental data of Lounasmaa and Sundström (1966) and of Jennings, Stanton, and Spedding (1957) shows reasonable agreement in view of the approximate nature of the calculations and the method of analyzing the data. (auth) (UK)

7065 MIGRATION OF INERT GASES IN IONIC CRYSTALS. **Norgett, M. J.; Lidiard, A. B. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag., 18: 1193-1210 (Dec. 1968).**

The migration and trapping of inert gases in ionic solids is of practical interest in reactor materials and of scientific interest as a result of experiments designed to simulate practical situations on better-defined systems. Many of these experiments have been carried out with crystals of alkali metal halides and alkaline earth fluorides. The classical Born model of an ionic crystal is extended to the calculation of the energies of migration and trapping of the inert gases Ar and Kr in K and Rb halides. The energies of solution and migration of interstitial Ar and Kr atoms are evaluated, as well as their binding energies into ionic vacancies and vacancy pairs. The results are in good general agreement with the observations on gas release from these crystals after neutron irradiation. In particular, the differing behavior of Ar in KF and in the other K halides is accounted for in terms of a strong trapping of the Ar atoms into vacancy pairs which occurs in KF. It is predicted that the behavior of Kr in RbF should be in even more striking contrast to its behavior in the other Rb halides. The implications for geologic dating of natural sylvine by determination of its ^{40}Ar content are mentioned. (auth) (UK)

Theoretical Physics

Refer also to abstracts 6883, 7351, and 7352.

7066 (ITF-68-51) THE KINETICS OF THE SPACE-UNIFORM BOSE CONDENSATE. Peletminskii, S. V.; Tsukanova, V. D.; Yatsenko, A. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 39p. (In Russian). Dep.

The integral equations are obtained for the nonequilibrium density matrix of the system of particles in the state of Bose condensation, in which the operators of creation and annihilation are considered as C numbers. The latter is based on the principle of the spatial relaxation of correlations. When formulating the equations for the density matrix, essential are the gradient transformations of the first kind which make it possible to eliminate the phase of the condensate particles changing rapidly with time from these equations. The kinetic equations for quasi particles and for the number of particles in the condensate are obtained in the weak-interaction gas model. (auth)

7067 STOCHASTIC COMPUTER SIMULATION OF ION MOTION IN A GAS SUBJECTED TO A CONSTANT ELECTRIC FIELD. **Skullerud, H. R. (Norges Tekniske Hoegskole, Trondheim, Norway). J. Phys., D (London), 1: 1567-8 (Nov. 1968).**

The stochastic computer simulation of ion motion in a gas subjected to an electric field involves the problem of statistically choosing free times between the collisions, when the velocity cannot be assumed constant during a free time. It is shown how free times can be chosen, without any approximations or numerical integrations, by the use of a piecewise velocity-independent mean collision frequency chosen to be greater than the actual collision frequency, combined with the assumption that an appropriate part of the collisions results in zero momentum transfer. (auth)

7068 MOTION OF ELECTRONS IN A RANDOM ELECTRIC FIELD. **Rozhkov, V. V. (Kharkov Inst. of Physics and Tech.). Ukr. Fiz. Zh., 13: 1712-16 (Oct. 1968). (In Russian).**

The motion of electrons in constant uniform magnetic and random electric fields is investigated. Interaction of electrons is taken as friction. The electric field is considered as a stationary Gaussian process. The distribution function of the electrons is found. The problem is solved by the methods of random differential equations. The random process is added to the Markovian one and then the Fokker–Planck equation for the distribution function is solved. The distribution function depends on both the random coordinates and velocities, and the random electric field. (auth)

7069 TOPOLOGICAL CHARACTERISTICS IN THE THEORY OF ANGULAR MOMENTA. **Shelepin, L. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 8: 827-32 (Oct. 1968). (In Russian).**

Relation of the theory of angular momenta to topological properties of polydimensional spaces is discussed. On this basis some new symbols are introduced that determine the transformation between different couplings of the Racah coefficients. Wave functions and interactions for a number of composite systems may be characterized by the topological invariants (the Betti groups). (auth)

7070 EXPANSION OF QUANTUM PHASE SPACE PROBABILITIES INTO CLASSICALLY DETERMINISTIC PARTS. **Gilson, J. G. (Queen Mary Coll., London). J. Inst. Math. Appl., 4: 410-13 (Dec. 1968).**

A formulation of Schroedinger quantum mechanics as expressed by phase space probabilities and their changes under small time increments, obtained by the author in an earlier paper (J. Appl. Probability, 5: (1968)), is studied further. The basic device arising in this formulation is a mathematical technique which is almost classical, but which replaces differential forms by difference equations and makes possible an expansion of the general phase space probability into parts all of which move deterministically in the classical sense. (auth) (UK)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 7219.

7071 DESIGN OF PHYSICAL EXPERIMENTS (STATISTICAL METHODS). Fedorov, V. V.; Pazman, A. (Joint Inst. for Nuclear Research, Dubna, USSR). Fortschr. Phys., 16: 325-55(1968).

In the present state of the development of theory and experimental techniques many investigations in physics, especially those concerning the properties of elementary particles, require sophisticated, expensive, and extended experiments to be performed. Actual experience shows that the design of such experiments by the methods of mathematical statistics allows, in most cases, to use the available means (e.g., time, money, and material) more effectively than in passive (non-planned) experiments. In view of this a more extensive application of the mathematical methods for designing experiments becomes necessary. In this review the existing methods of designing experiments are described in a universally accessible form. Examples concerning mainly experiments on the phase shift analysis of elastic scattering and measurements of differential effective cross sections are considered in this review. For simplicity, these examples are presented schematically. The examples are selected from the domain of nuclear physics not by chance but because experiments in this region are specially expensive. (auth)

Electromagnetic

7072 (DESY-68/48) INELASTIC ELECTRON PROTON SCATTERING AT HIGH MOMENTUM TRANSFERS. Albrecht, W.; Brasse, F. W.; Dorner, H.; Flauger, W.; Frank, K.; Gayler, J.; Hultschig, H.; May, J.; Ganssauge, E. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sept. 1968. 19p. Dep.

Inelastic electron-proton scattering has been measured by detecting the scattered electron, thus obtaining the total absorption cross section for virtual photons. Two complete spectra from threshold to a pion nucleon mass of W = 2 GeV were taken at 48.3° and fixed primary energies of 3.963 GeV and 5.159 GeV, respectively, corresponding to a momentum transfer at the first resonance of $q^2 = 3.98$ (GeV/c)^2 and $q^2 = 5.84$ (GeV/c)^2. In addition, a measurement at 47.9° and at a primary energy of 3.306 GeV in the region of the first resonance is reported. (auth)

7073 (DESY-68/50) RHO PRODUCTION WITH POLARIZED PHOTONS. Criegee, L.; Garrell, M. H.; Gottfried, C.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sept. 1968. 13p. Dep.

The process $\gamma + p \rightarrow p + \rho^0 \rightarrow p + \pi^+ + \pi^-$ has been studied with polarized photons between 2.0 and 2.5 GeV. Decay pions and recoil proton were detected with a wire plane system. A strong preference for ρ^0-decay parallel to the polarization vector, expressed by the ratio $\sigma_\perp/\sigma_\parallel = 0.17 \pm 0.07$, which indicates the predominance of diffractive rho production is found. (auth)

7074 (LAL-1199) STUDY OF THE ϕ MESON PRODUCTION WITH THE ORSAY ELECTRON-POSITRON COLLIDING BEAMS. Augustin, J. E.; Bizot, J. C.; Buon, J.; (and others) (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Oct. 1968. 14p. Dep.

The $e^+e^- \rightarrow \phi$ reaction was measured by the $K_S^0 K_L^0$ and 3π decay modes of the ϕ. $\Gamma(\phi \rightarrow \text{all})$, $\Gamma(\phi \rightarrow e^+e^-)$, as well as $B(\phi \rightarrow K_S^0 K_L^0)$, $B(\phi \rightarrow K^+K^-)$, and $B(\phi \rightarrow \pi^+\pi^-\pi^0)$ were deduced. (auth)

7075 (LAL-1202) ω^0 PRODUCTION BY e^+e^- ANNIHILATION. Augustin, J. E.; Benaksas, D.; Buon, J.; (and others) (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Nov. 1968. 12p. Dep.

The reaction $e^+e^- \rightarrow \omega^0$ has been measured by detecting the charged pions of the $\pi^+\pi^-\pi^0$ decay mode of the ω^0. A partial decay width of ω^0 into e^+e^-, $\Gamma_{e^+e^-} = .94 \pm .18$ keV, is deduced from this result. (auth)

7076 (LAL-1203) STUDY OF ELECTRON-POSITRON ANNIHILATION INTO $\pi^+\pi^-$ ON THE ρ^0 RESONANCE. Augustin, J. E.; Bizot, J. C.; Buon, J.; (and others) (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Nov. 1968. 14p. Dep.

The electromagnetic form factor of the pion has been determined in the ρ^0 resonance region by measuring the absolute cross section of the reaction $e^+ + e^- \rightarrow n^+ + n^-$ with the Orsay storage ring. More than 800 pion pairs have been detected. The excitation curve has been fitted with a Breit-Wigner formula which leads to the following values: $\sigma_{peak} = (1.69 \pm 0.21)\ 10^{-30}$ cm^2; $m_\rho = (770 \pm 4)$ MeV; $\Gamma_\rho = (111 \pm 6)$ MeV. The partial width of the ρ^0 going into e^+e^- thus obtained is: $\Gamma_\rho \rightarrow e^+e^- = (7.36 \pm 0.7)$ keV. (auth)

7077 INELASTIC ELECTRON PROTON SCATTERING AT HIGH MOMENTUM TRANSFERS. Albrecht, W.; Brasse, F. W.; Dorner, H.; Flauger, W.; Frank, K.; Gayler, J.; Hultschig, H.; May, J. (DESY, Hamburg). Phys. Lett., 28B: 225-8(Nov. 25, 1968).

Inelastic electron proton scattering has been measured by detecting the scattered electron, thus obtaining the total absorption cross section for virtual photons. Two complete spectra from threshold to a pion nucleon mass of W = 2 GeV were taken at $\theta_e = 48.3°$ and fixed primary energies of 3.963 GeV and 5.159 GeV, respectively, corresponding to a momentum transfer at the first resonance of $q^2 = 3.98$ (GeV/c)^2 and $q^2 = 5.84$ (GeV/c)^2. In addition, a measurement at $\theta_e = 47.9°$ and at a primary energy of 3.306 GeV in the region of the first resonance is reported. (auth)

7078 INVESTIGATION OF RESIDUAL POLARIZATION OF NEGATIVE μ^- MESONS IN THE WATER AT DIFFERENT TEMPERATURE AND IN HYDROCARBON. Evseev, V. S.; Roganov, V. S.; Chernogorova, V. A.; Myasishcheva, G. G.; Obukhov, Yu. V. (Joint Inst. for Nuclear Research, Dubna, USSR. Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 8: 741-2(Oct. 1968). (In Russian).

Relative values of residual polarization P_μ for the water at different temperatures from $-196°$ up to $+100°$ and for some hydrocarbons are measured using the method of μ^- meson spin precession in transversal magnetic field. The data obtained contradict the concept on the dominant depolarization of μ^- mesons in cascade mesoatomic transitions and require macroscopic parameters of the matter for their explanation. (auth)

Weak

7079 A MEASUREMENT OF THE BRANCHING RATIO OF THE CP VIOLATING DECAY MODE $K_L^0 \rightarrow 2\pi^0$. Budagov, I. A. (CERN, Geneva); Cundy, D. C.; Myatt, G.; (and others). Phys. Lett., 28B: 215-19(Nov. 25, 1968).

Using a heavy liquid bubble chamber, the branching ratio $(K_L^0 \rightarrow 2\pi^0)/(K_L^0 \rightarrow 3\pi^0)$ is measured to be $(4.5 \pm 1.8) \times 10^{-3}$. Combined with a previously reported measurement of the branching ratio $(K_L^0 \rightarrow 3\pi^0)/(K_L^0 \rightarrow \text{all modes})$, $|\eta_{00}|$ is found to be $(2.2 \pm 0.4) \times 10^{-3}$. (auth)

Strong (Baryon-Induced)

7080 (COO-1195-151) REGGEIZED PION EXCHANGE AND THE 1425-MeV $\Delta^{++}(1238)\pi^-$ ENHANCEMENT IN $pp \rightarrow pp\pi^+\pi^-$ AT 7.9 GeV/c. Grether, D. F.; Sard, R. D. (Illinois Univ., Urbana. Dept. of Physics). Dec. 2, 1968. Contract AT(11-1)-1195. 13p. Dep. CFSTI.

A Reggeized pion exchange model is developed that gives a generally adequate description of the decay mode and decay angular distributions of any substantial resonance contribution to the 1425 MeV enhancement. They do not appear to be consistent with those expected of the N*(1400), the P_{11} resonance of π^-p phase shift analysis. (auth)

7081 (COO-1764-17) $\rho^-\pi^-$ ENHANCEMENTS PRODUCED BY 2.3-GeV/c NEGATIVE PIONS IN DEUTERIUM. Benvenuti, A.; Marquit, E.; Oppenheimer, F.; Vander Velde, J. C. (Minnesota Univ., [Minneapolis]). Apr. 1968. Contract AT(11-1)-1764. 15p. (CONF-680439-4). Dep. CFSTI.

From Meeting of the American Physical Society, Washington, D. C.

A total of 2405 events consisting of 877 4-prong and 1528 3-prong events fitting the reaction $\pi^- + d \rightarrow p_s + p + \pi^- + \pi^- + \pi^0$ that indicate $\rho^-\pi^-$ enhancements at 970 and 1080 MeV and possibly at 1160 MeV are reported. The enhancements seem to be associated with peripheral interactions. Attempts to investigate the possibility that these peaks are artificially enhanced by ρ selection and whether the peaks are reflections of $\Delta(1236)$ production are discussed. (C.E.S.)

7082 PROTON-NEUTRON FINAL-STATE INTERACTION. Boyd, Douglas P. New Brunswick, N. J., Rutgers - The State Univ., 1968. 139p.

Thesis.

The reactions H(d,2p)n and D(p,2p)n were studied at a proton bombarding energy of 16.0 MeV and deuteron bombarding energies of 16.0 MeV and 10.0 MeV. Two protons were detected in coincidence using solid-state detectors at angles which enhance the p-n final-state interaction. The coincidence resolving time was sharpened by using time-energy correlation techniques which utilize an on-line SDS-910 computer. The data were analyzed using the data-simulation technique. A simple theory which contained three adjustable parameters was found to produce satisfactory fits. In this theory the final-state interactions are accounted for by assuming additive enhancements for each pair of final-state particles and each spin state. The primary interaction is approximated by the sum of a constant amplitude plus the spectator effect amplitude. The widths of the final-state interaction peaks are in good agreement with Watson theory using the known p-n scattering length. The most accurately determined scattering length was extracted from the 16 MeV p + d data and was $a^s_{np} = -23.8 \pm 0.5$ fm. This agreement indicates that interference effects are not important in these reactions if coincidence techniques are employed. Using similar methods, a comparative study of the n + d reaction in order to measure the n-n scattering length should be fruitful. (Diss. Abstr.)

7083 AN INVESTIGATION OF THE 1.4 GeV/c^2 NUCLEON ISOBAR IN PROTON–PROTON INTERACTIONS. Tan, T. H. (Stanford Univ., Calif.); Perl, M. L.; Martin, F.; Chinowsky, W.; Kinsey, R.; Klein, S.; Schmidt, P.; Mandelkern, M.; Schultz, J. Phys. Lett., 28B: 195-8(Nov. 25, 1968).

The production of N*(1400) isobar in the reaction $pp \rightarrow pN^{*+}(1400)$, where $N^*(1400) \rightarrow n\pi^+$ and $p\pi^0$, is investigated with the aid of one-pion exchange model. The one-pion exchange mechanism does not seem to dominate the production process. The isospin of N*(1400) is found to be $I = \frac{1}{2}$, and the elasticity of the resonance is estimated to be 0.66. (auth)

7084 PRODUCTION OF NUCLEON RESONANCES IN PROTON–PROTON COLLISIONS AT HIGH ENERGY AND LARGE MOMENTUM TRANSFERS. Allaby, J. V.; Binon, F.; Diddens, A. N.; (and others). Phys. Lett., 28B: 229-32(Nov. 25, 1968).

Experimental results are presented on the excitation of the nucleon isobars N*(1518) and N*(1688) in proton-proton collisions at an incident momentum of 19.2 GeV/c and in the range of four-momentum squared $0.6 \leq |t| \leq 5.8$ GeV^2. (auth)

Strong (Meson-Induced)

Refer also to abstracts 7147, 7157, and 7221.

7085 (COO–1764-18) HIGH-ENERGY PION–DEUTERON ELASTIC SCATTERING. Chase, R. C.; Coleman, E.; Rhoades, T. G. (Minnesota Univ., Minneapolis); Fellinger, M.; Gutman, E.; Lamb, R. C.; Schroeder, L. S. (Iowa State Univ. of Science and Technology, Ames). July 1968. Contract AT(11-1)-1764. 10p. (CONF-680809-41). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

Measurements of π^-d elastic scattering at 3.75 GeV/c are presented, covering the range of four-momentum transfer $0.2 \leq |t| \leq 0.9$ (GeV/c)^2. The results of the Glauber high energy approximation including double charge exchange and the deuteron state are compared with the data. (auth)

7086 (DESY–68/56) LEPTONIC DECAYS OF VECTOR MESONS: THE BRANCHING RATIO OF THE ELECTRON–POSITRON DECAY MODE OF THE PHI MESON. Becker, U.; Bertram, William K.; Binkley, M.; Jordan, C. L.; Knasel, T. M.; Marshall, R.; Quinn, D. J.; Rohde, M.; Smith, A. J. S.; Ting, Samuel C. C. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany). Massachusetts Inst. of Tech., Cambridge). Oct. 1968. 11p. Dep.

An experiment designed to measure the branching ratio of the phi meson to e^+e^- was performed at DESY, by measuring phi production and phi decay to e^+e^- with the same apparatus. The results of this experiment, based on 10^4 $\phi \rightarrow K^+K^-$ events and 41 $\phi \rightarrow e^+e^-$ events on carbon, yield a branching ratio of $(2.9 \pm 0.8) \times 10^{-4}$. This result is compared with various theoretical predictions. (auth)

7087 (KFKI-22/1968) ON THE 1350-MeV $\Lambda\gamma$ PEAK PRODUCED IN π^-p INTERACTION. Bozoki, G.; Fenyves, E.; Gemesy, T.; (and others) (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Oct. 9, 1968. 6p. Dep.

The existence of the $\Lambda\gamma$ peak between 1300 and 1400 MeV was supported by measurements. The explanation of this peak by means of the hypothetical $\Lambda\eta$ (1680 MeV) resonance can be rejected on a 97% confidence level. (auth)

7088 (UCRL–18322) K^+d INTERACTIONS NEAR 1 GeV/c. Hirata, Allan A.; Wohl, Charles G.; Bland, Roger W.; Goldhaber, Gerson; Hall, Bronwyn H.; Kadyk, John A.; Seeger, Victor H.; Trilling, George H. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1968. Contract W-7405-eng-48. 35p. (CONF-680809–36). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

Detailed experimental results on the K^+d interaction near 1 GeV/c are presented. Measurements on several inelastic cross sections are given, and the I = 0 inelastic cross section $KN\pi$ is deduced. The latter corresponds largely to K* production and rises rapidly from 0.860 to 1.210 GeV/c. The results of a phase shift analysis of the charge-exchange data up to 0.860 GeV/c are also given. Furthermore the charge-exchange data are compared with a Regge model and are found to be consistent with the results of high-energy fits. So far an unequivocal answer cannot be given to the crucial question of whether or not a resonance occurs in the I = 0 KN system. (auth)

7089 USE OF IMAGES OF VELOCITY SPACE TO STUDY THE KINEMATICS OF π^-p INTERACTIONS AT 7.5 GeV WITH IDENTIFIED PROTON. Belyakov, V. A.; Bubelev, E. G.; Kuznetsova, E. S. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.), 8: 118-21(Aug. 20, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 197-202(Aug. 20, 1968).

Using the new method of analyzing kinematics in images of Lobachevskii velocity space proposed by one of the authors (Bubelev), 300 of the ~1300 4-prong π^-p interactions in propane at energy 7.5 ± 0.6 GeV with the proton identified by ionization ($p_p \lesssim 1$ GeV/c) were analyzed. (auth)

7090 A STUDY OF THE REACTIONS $K^-p \rightarrow p\bar{K}^0\pi^-$, $K^-p \rightarrow p\bar{K}^0\pi^0\pi^-$, AND $K^-p \rightarrow n\bar{K}^0\pi^+\pi^-$ FROM 2.1 TO 2.7 GeV/c. Friedman, Jerome Harold. Berkeley, Calif., Univ. of California, 1968. 315p.

Thesis.

The reactions $K^-p \rightarrow p\bar{K}^0\pi^-$, $K^-p \rightarrow p\bar{K}^0\pi^0\pi^-$, and $K^-p \rightarrow n\bar{K}^0\pi^+\pi^-$ are studied in detail in the LRL 72-in. hydrogen bubble chamber in the center of mass energy range 2.27 to 2.51 GeV. Total cross sections for these reactions as a function of center of mass energy are presented. Copious resonance production is observed in all of these final states. This resonance production is studied with the aid of a maximum likelihood technique and the relative rates of the well known resonances are presented as a function of center of mass energy. The differential cross section and decay correlation parameters are measured as a function of production angle and center of mass energy for the reaction $K^-p \rightarrow K^*_A{}^-(892)$ p using the likelihood method. The differential cross section and parameters of the joint decay angular distributions for the double resonance production reaction $K^-p \rightarrow \bar{K}^*_A(892)$ $N^*_A(1238)$ are also measured as a function of production angle and center of mass energy. The results of the analyses on the reactions $K^-p \rightarrow K^*_A{}^-(892)$ p and $K^-p \rightarrow K^*_A(892)$ $N^*_A(1238)$ are compared to the predictions of the absorptive peripheral model, the Regge pole model, and the quark model. Finally, the $K\pi\pi$ mass spectra are studied and the structure therein discussed. (Diss. Abstr.)

7091 RESONANCE PRODUCTION, PARTICULARLY $Y^*_1(1385)$ AND ρ, IN $K^-p \rightarrow \Lambda\pi^+\pi^-$ AND $K^-p \rightarrow \Lambda\pi^+\pi^-$; $p_{K^-} = 2.1$ TO 2.7 GeV/c. Siegel, Daniel Menahem. Berkeley, Calif., Univ. of California, 1968. 123p.

Thesis.

Some 20,000 $K^-p \rightarrow \Lambda\pi^+\pi^0\pi^-$ and 10,000 $K^-p \rightarrow \Lambda\pi^+\pi^-$ events are identified in the 72-inch hydrogen bubble chamber. Analysis of these reactions, by means of maximum likelihood fits to comprehensive models involving known resonances, yields cross sections and production angular distributions for quasi-two-body states $Y^*_1(1385)^0\,\rho^0$, $Y^*_1(1385)^\pm\,\pi^\mp$, and $\Lambda^0\rho^0$. Analysis of decay angular distributions for peripheral reactions indicates predominance of K meson exchange for $K^-p \rightarrow Y^*_1(1385)^+\,\rho^-$, and K* exchange for $K^-p \rightarrow Y^*_1(1385)^+\,\pi^-$. (Diss. Abstr.)

7092 CONFIRMATION OF THE A_2 SPLITTING NEAR THRESHOLD. Benz, H.; Chikovani, G. E.; Damgaard, G.; (and others) (CERN, Geneva). Phys. Lett., 28B: 233-6(Nov. 25, 1968).

The shape of the A_2 resonance has been measured in $\pi p \rightarrow pA_2$ at 2.6 GeV/c, i.e. near threshold, with A_2 produced at minimum momentum transfer. The results confirm, with a new method and instrument, the A_2 splitting found previously with the Jacobian-peak method. (auth)

7093 BACKWARD CHARGE EXCHANGE $\pi^- + p \rightarrow \pi^0 + n$ REACTION IN THE MOMENTUM RANGE 1.55 TO 3.8 GeV/c.

Antopolskii, V. D.; Bayatyan, G. L.; Brakhman, E. V.; (and others). (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett., 28B: 223-4(Nov. 25, 1968).

The results of measurements on pion-nucleon charge exchange scattering at $\cos\theta^* = -0.99 \pm 0.01$ in the momentum range 1.55 to 3.8 GeV/c are reported. (auth)

7094 BACKWARD ELASTIC SCATTERING OF π^- MESONS BY NEUTRONS IN THE MOMENTUM RANGE 1.5 TO 3.8 GeV/c. Antopolskii, V. D.; Bayatyan, G. L.; Brakhman, E. V.; (and others). (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett., 28B: 220-2(Nov. 25, 1968).

Measurements of π^-n backward elastic scattering with $-0.95 > \cos\theta^* > -1$ and momenta between 1.5 and 3.8 GeV/c are reported. (auth)

7095 A STUDY OF THE REACTION $\pi^- + p \rightarrow \Lambda + \bar{\Lambda} + n$ AT 7 AND 12 GeV/c. Beusch, W. (Eidgenoessiche Technische Hochschule, Zurich); Fischer, W. E.; Pepin, M.; Polgar, E. E.; Michelini, A.; Websdale, D.; West, C. H. Phys. Lett., 28B: 211-14(Nov. 25, 1968).

Over 100 unambiguous $\pi^- + p \rightarrow \Lambda + \bar{\Lambda} + n$ events have been observed in a magnet spark chamber. The data provide good evidence for peripheral production of $\Lambda\bar{\Lambda}$ and $n\bar{\Lambda}$ (via meson exchange) and against peripheral $n\bar{\Lambda}$ (double baryon exchange). No resonances in the $\Lambda\bar{\Lambda}$ system are observed. Angular distributions and $\Lambda(\bar{\Lambda})$ polarizations are analyzed. (auth)

7096 COHERENT PRODUCTION OF 5-PION FINAL STATES FROM NUCLEI AT 16 GeV/c. Huson, R. (Faculte des Sciences, Orsay, France); Lubatti, H. J.; Six, J.; (and others). Phys. Lett., 28B: 208-10(Nov. 25, 1968).

Coherent production of $2\pi^+3\pi^-$ occurs with cross section (0.1 ± 0.03) mb/nucleus in 16 GeV π^- C_2F_5Cl collisions, compared with (4.0 ± 0.6) mb/nucleus for $\pi^+2\pi^-$ coherent production. Comparison of $2\pi^+3\pi^-$ and $\pi^+2\pi^-$ yields 90% confidence upper limits ($\rho^0 \rightarrow 2\pi^+2\pi^-$) < 0.2% ($\rho^0 \rightarrow \pi^+\pi^-$) and ($A_1 \rightarrow 2\pi^+3\pi^-$) < 0.2% ($A_1 \rightarrow \pi^-\rho^0$). The 5π mass peaks in the 1.9 GeV region. Indications of ρ^0 and A_1 substructure are seen. (auth)

7097 EVIDENCE FOR A BROAD SCALAR Kπ RESONANCE NEAR 1.1 GeV. Trippe, T. G.; Chien, C.-Y.; Malamud, E.; Mellema, J.; Schlein, P. E.; Slater, W. E.; Stork, D. H.; Ticho, H. K. (Univ. of California, Los Angeles). Phys. Lett., 28B: 203-7 (Nov. 25, 1968).

A one-pion-exchange pole-extrapolation analysis of $K^+p \rightarrow K\pi\Delta^{++}$ at 7.3 GeV/c provides evidence for the existence of a broad scalar $T = \frac{1}{2}$ Kπ resonance near 1.1 GeV. The angular distribution in the Kπ center-of-mass is consistent with this result. (auth)

7098 STUDY OF RESONANT STRUCTURE IN THE $\pi^-\eta$ SYSTEM FROM THE REACTION $\pi^-p \rightarrow \pi^-p\eta$ AT 2.26 GeV/c. Wiecko-Wieckowicz, R. P.; Reynolds, B. G.; Albright, J. R.; Bradley, R. H.; Harms, B. C.; Harrison, W. C.; Lannutti, J. E.; Sims, W. H. (Florida State Univ., Tallahassee). Phys. Lett., 28B: 199-202 (Nov. 25, 1968).

Enhancements in the $\pi^-\eta$ mass spectrum from the reaction $\pi^-p \rightarrow \pi^-p\eta$ at 2.26 GeV/c appear to be consistent with production of the $\pi_\nu(1016)$ and the $A_2^1(1270)$ mesons. Evidence is presented that favors $J^P = 2^+$ for the A_2^1. (auth)

7099 PION–DEUTERON COHERENT SCATTERING AT 895 MeV/c. Bradamante, F.; Conetti, S.; Fidecaro, G.; Fidecaro, M.; Giorgi, M.; Penzo, A.; Piemontese, L.; Sauli, F.; Schiavon, P. (CERN, Geneva). Phys. Lett., 28B: 191-4(Nov. 25, 1968).

The elastic scattering cross-section of π^- on deuterium at 895 MeV/c measured with counters and wire spark chambers is given in a region of momentum transfer between 0.16 and 0.96 $(GeV/c)^2$. (auth)

7100 STUDY OF THE REACTION $\pi^-p \rightarrow \Delta^{2+}(1236)\pi^-\pi^-$ AT 3.25 GeV/c π^--MESON. Vetlitskii, I. A.; Guzhavin, V. M.; Kliger, G. K.; Kolganov, V. Z.; Lebedev, A. V.; Lomkatsi, G. S.; Narodetskii, I. M.; Smolyankin, V. T.; Sokolov, A. P. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 8: 743-9 (Oct. 1968). (In Russian).

When studying systematically 4-prong events produced in the 55 cm liquid hydrogen chamber by 3.25 GeV/c π^-mesons, of 160,000 photographs 1108 events of the reaction $\pi^-p \rightarrow \Delta^{2+}(1236)\pi^-\pi^-$ were selected and studied. By means of the modified Chew–Low formula the values $\sigma_{\pi\pi}$ (T = 2) for five regions of the effective masses of two π^- mesons were obtained. The scattering length is found to be $|a_2| = (1.7 \pm 0.8) \cdot 10^{-14}$ cm. Assuming "purely elastic" $\pi\pi$ interaction, the phase analysis is made to determine the phase shift δ_{10} and δ_{22}. After excluding the events lying in the region of ρ^0 meson, there is an excess of events in the region of 800 to 850 MeV in the $\pi^-\pi^-$-meson spectrum. To confirm this excess for sure, additional investigations are necessary. (auth)

7101 REACTIONS $\pi^-p \rightarrow \pi^-p$ AND $\pi^-p \rightarrow \pi^-\pi^0p$ AT 1.7 GeV/c. Allen, D. D.; Fisher, G. P.; Godden, G.; Kopelman, J. B.; Libby, L. Marshall; Sears, R. (Univ. of Colorado, Boulder). Nuovo Cim., 58A: 701-27(Dec. 21, 1968).

The reactions $\pi^-p \rightarrow \pi^-p$ and $\pi^-p \rightarrow \pi^-\pi^0p$ for 1.7 GeV/c incident π^- were studied, in 3094 and 2244 interactions respectively, identified from 10 106 two-prong events measured in film exposed at the BNL 20 in. hydrogen bubble chamber. The differential elastic-scattering cross section is found to show a first and second diffraction peak and a first diffraction minimum with indications of a second minimum and onset of a third maximum. The experimental curve was fitted by a black-disc optical-model formula with radius (0.80 ± 0.03) fm and by a differential cross section computed from the Dirac equation depending on two ranges, 0.7 fm attractive imaginary and 0.4 fm repulsive. The dominant mode (~40%) of the $\pi^-\pi^0p$ production is through the two-body channel, $\pi^-p \rightarrow \rho^-p$. The following cross sections are found: $\sigma(\pi^-p \rightarrow \pi^-\pi^0p) = (5.41 \pm 0.54)$ mb, $\sigma(\pi^-p \rightarrow \rho^-p) = (2.06 \pm 0.21)$ mb. The differential rho-meson production cross section shows a diffraction peak having a dependence $(d\sigma/dt)$ $(\pi^-p \rightarrow \rho^-p) = \{(2.5 \pm 0.2) \exp[(-5.3 \pm 0.5)t]\}$ mb/$(GeV/c)^2$, where t is the squared four-momentum transfer between incoming and outgoing proton in $(GeV/c)^2$, and a second diffraction maximum. It was fitted by an optical-model formula for a bright ring of radius 0.80 fm and ring thickness 0.25 fm. The cross section for $\sigma(\pi^-p \rightarrow \pi^-p$ + neutrals) was found to be (0.36 ± 0.04) mb. From the inelastic data the Chew–Low dipion scattering cross section was computed, using various form factors. A form factor of unity is found to be acceptable. (auth)

Particle Interactions and Properties (Theoretical)

General

7102 (NYO-2962-7) THE INTERACTION OF RADIATION WITH MATTER. A Comprehensive Report 1962–1968. (New York Univ., N. Y. Radiation and Solid State Lab.). Dec. 1967. Contract AT(30-1)-2962. 100p. Dep. CFSTI.

A general review on the interaction of radiation with matter including fluorescence, ionization, persistent internal polarization, and energy transfer reactions is presented. A review on heavy ion research is also presented. This research includes development of heavy ion accelerator facility, channeling, screening of heavy charged particles in semiconductors, characteristic x-ray production by heavy ions, unified sputtering theory, and channeling in organic crystals. (B.G.D.)

7103 REGGE POLE BEHAVIOR OF EXTENDED PARTICLES. Tanaka, Sho (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), Suppl. No. 41, 194-240(1968).

An extended particle is described on the basis of the Regge pole hypothesis. The internal structure is specified as a realization of the Lorentz group over all the region of the outer four-momentum P_μ, being characterized by the complex spin angular momentum $\alpha(P_\mu^2)$ dependent on P_μ^2. Similarly, the unitary spin is conjectured to be derived from the internal space-time structure of an extended particle. The corresponding internal structure is also specified group-theoretically over all the region of the four-momentum by the complex values of Casimir invariants of the Reggeized unitary symmetry group, $\nu(P_\mu^2)$'s dependent on P_μ^2. These "Regge trajectories" $\alpha(P_\mu^2)$ and $\nu(P_\mu^2)$'s are considered to be determined by basic equations for an extended particle which relate the outer four-momentum to the internal structure. Nonlocal interactions between extended particles are almost uniquely determined by virtue of the group-theoretical characterization of the internal structure. The complex generalization of unitary spin leads one naturally to a result of the broken symmetry. (auth)

7104 EXTENDED PARTICLE MODEL OF ELEMENTARY PARTICLES. Hara, Osamu; Goto, Tetsuo (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto), Suppl. No. 41, 56-129(1968).

A unified model of elementary particles, especially that of hadrons, is discussed based upon an assumption that the elementary particles are not mathematical points but have some spatial extension, trying to identify the internal levels of motion carried by this extended structure with the actual elementary particles. The simplest possibility for such an approach is to assume that this structure is rigid. In this case, the internal motion is the rotation around the center of mass, and the internal states are specified by three quantum numbers J, K, and M, which specify the magnitude of the angular momentum due to this rotation and its

component along the third axis of the body fixed and the laboratory fixed frame, respectively. Clearly, J and M should be interpreted as the magnitude and the third component of the spin, while it is shown that K can be identified with the twice of the baryonic (or leptonic) number. The equation of motion to be satisfied by such a system is a generalization of the Feynman–Gell–Mann equation which is equivalent to the generalized Dirac equation. Further, it can be shown that in this model the mirror image of a particle is its antiparticle. Therefore, the invariance of the physical law under the space inversion leads to the conservation of CP rather than the conservation of P. If we allow deformability, the body possesses, in addition to the degree of freedom of the rotation, the degree of freedom of the deformation. It can be shown that in the first approximation in which these deformations are approximated by simple harmonic oscillations near the equilibrium points, the motion of such a system near the ground state can be described in terms of the excitons which describe the rotation and the deformation of the system, in which this deformation is caused by the Coriolis force due to the rotation excited by the excitons. It is shown that as far as the spin and the unitary spin quantum numbers are concerned, these excitons can be identified with the quark and the antiquark. But they obey the Bose statistics and have the rest mass about one third of the nucleon mass and moreover it can be shown that in this model the triality is restricted to zero. Therefore, particles with fractional electric charge or fractional baryonic number do not appear and it is shown that as far as the low lying levels of the hadrons are concerned, the elementary particles can be understood consistently as the excited state of a deformable sphere. Thus in this model structure constants like spin, baryonic (leptonic) number, unitary spin, ..., etc., are introduced as quantum numbers specifying the internal motion, and the nonconservation of parity or the existence of the internal symmetry like SU_3 or SU_6 appears as rather general features of the extended particles not necessarily depending upon their specific form, and it is concluded that this model, although naive and simple minded, seems to match very well with the essential features of elementary particles, and may be taken as a starting point for their better understanding. (auth)

7105 THE "ANOMALOUS ZITTERBEWEGUNG" OF COMPOSITE PARTICLES. Barut, A. O.; Kleinert, H.; Malin, S. (Univ. of Colorado, Boulder). Nuovo Cim., 58A: 835-47(Dec. 21, 1968).

It is shown that the range of the zitterbewegung for generalized infinite-component theories describing realistic composite particles is not the Compton wavelength, but the analog of the Bohr radius. This range is quite different from that in the case of simple Majorana-type equations where it is equal to the Compton wavelength for the ground state. The problems associated with the consistent definition of relativistic position operators for composite particles are discussed. (auth)

7106 EXACT FINAL-STATE EQUATIONS WITH POLES. Riordan, F. (Yale Univ., New Haven). Nuovo Cim., 58A: 649-67(Dec. 21, 1968).

Relativistic equations for the decay amplitude into three particles are found, which are of the Faddeev kind. They serve to extract the normal threshold cuts in the two-particle subenergies. They are reduced to a many-channel two "particle" integral equation with the quasi-particle off the mass shell. The kernel is a solution of the Faddeev equations with the quasi-particle pole extracted from the two-particle amplitude. The simplest approximation to this is shown to retain the most important singularity structure of the decay amplitude. (auth)

Electromagnetic

Refer also to abstracts 7139, 7142, and 7151.

7107 (UCRL-18487) DECAYS OF NEUTRAL PSEUDOSCALAR MESONS INTO LEPTON PAIRS. Quigg, C.; Jackson, J. D. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 24, 1968. Contract W-7405-eng-48. 44p. Dep. CFSTI.

The branching ratio $\Gamma(P \to l^+l^-)/\Gamma(P \to \gamma\gamma)$ is calculated to lowest contributing order in quantum electrodynamics, with a vector meson model for the pseudoscalar meson form factor. The processes $\eta \to \mu^+\mu^-$; $\eta \to e^+e^-$; $K_1^0 \to \mu^+\mu^-$; $K_2^0 \to e^+e^-$; and $\pi^0 \to e^+e^-$ are treated. Results are compared with those of previous calculations. (auth)

7108 NUCLEON FORM FACTOR AT ASYMPTOTICALLY GREAT TRANSFERRED MOMENTA. Khimich, I. V.; Shuba, I. M. Ukr. Fiz. Zh., 13: 1622-7(Oct. 1968). (In Russian).

The connection between a module of the form factor f(t) and its phase Ima(t) was considered at asymptotically great transferred momenta t. The essential strengthening of a lower Jaffe's limit for the form factor f(t) at asymptotically great transferred momenta t in a physical region was obtained, proceeding from the most general axioms of the modern quantized field theory and highly weak assumptions concerning a character of the oscillations in f(t) and the ratio of the $\xi(t) = \text{Im } a(t)/\text{Re } a(t)$. (auth)

7109 NON-ABELIAN COMPTON EFFECT ON SPIN-ONE TARGETS. Kumar, Arvind (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 175: 2148-54(Nov. 25, 1968).

Scattering of isovector photons by spin-1 targets is considered in detail. To first order in photon frequency, three new theorems are obtained. Two of these are analogous to the Cabibbo-Radicati theorem and the Bég theorem (for the nucleon case). The third is a new theorem involving only the quadrupole moment. Several new theorems up to second order in photon frequency are obtained by using Singh's lemma. On the basis of these results and the earlier results for spin-0 and spin-$\frac{1}{2}$ targets, various theorems up to first and second order are conjectured for arbitrary-spin targets. (auth)

7110 PHOTOPRODUCTION OF STRANGE PARTICLES ON PROTON AND NEUTRON NEAR THRESHOLD. Rekalo, M. P. (Kharkov Inst. of Physics and Tech.). Ukr. Fiz. Zh., 13: 1706-11(Oct. 1968). (In Russian).

Photoproduction of strange particles on nucleons near threshold is considered in the Born approximation. For the ratios of different process sections the predictions, which are in agreement with the experiment, are obtained with a certain choice of the baryon-meson interaction constants. The ratios valid within the framework of SU(3)-symmetry are used for baryon magnetic moments. The difference is explained in angular dependence of the sections of the processes $\gamma + p \to \Lambda + K^+$ and $\gamma + p \to \Sigma^0 + K^+$. (auth)

7111 CONTINUOUS-MOMENT SUM RULES AND PION CONSPIRACY IN PHOTOPRODUCTION. Raman, K. (Brown Univ., Providence); Vasavada, Kashyap V. Phys. Rev., 175: 2191-4(Nov. 25, 1968). (NYO-2262TA-190).

Continuous-moment sum rules are used for examining the validity of the pion-conspiracy hypothesis in pion photoproduction. The trajectory and residue functions of the pion and conspirator trajectories are estimated. (auth)

7112 VECTOR DOMINANCE, $\omega-\varphi$ MIXING, AND SUPPRESSION OF φ-MESON PHOTOPRODUCTION. Gerasimov, S. B. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.), 8: 123-5(Aug. 20, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 205-8(Aug. 20, 1968).

It is attempted to show that the φ-meson photoproduction cross section at high energies is sensitive to a deviation of the $\omega-\varphi$ mixing angle from the ideal angle $\tilde{\theta} \simeq 35.3°$ customarily used in the calculations and also to a possible violation of U-invariance of the electromagnetic hadron interaction. Allowance for these factors leads to an appreciable suppression of the φ-meson photoproduction process and helps decrease the disparity between experiment and theory. (auth)

7113 ASYMMETRY IN THE ELECTROPRODUCTION $e^- + p \to e^- + n + \pi^+$ AND THE π^+-MESON ELECTROMAGNETIC FORM FACTOR. Goryachkin, V. G.; Semikoz, V. Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 8: 776-82(Oct. 1968). (In Russian).

Asymmetry in the electroproduction $ep \to en\pi^+$ on the polarized proton target is calculated using the resonance model by Fubini, Nambu, and Watagin. In this model the asymmetry is determined by the pion electromagnetic form factor. It is shown that the asymmetry is more sensible to the value of the form factor than the cross section on the nonpolarized target. Possible experiments to test the used model are indicated. (auth)

7114 BREMSSTRAHLUNG AND DETERMINATION OF ELECTROMAGNETIC PARAMETERS OF PARTICLES. Zakharov, V. I.; Kondratyuk, L. A.; Ponomarev, L. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 8: 783-92 (Oct. 1968). (In Russian).

A possibility to determine multipole moments of particles in processes with soft γ-quanta emission is discussed. It is shown that the magnetic and quadrupole moments of particles with the spin 1 and $\frac{1}{2}$ may be determined from the angular distribution of γ-quanta in radiative decays of these particles. It is also shown that in case of radiative decays of resonances, the γ-quanta emission by initial particles should be taken into account. (auth)

7115 MESON PHOTOPRODUCTION BY POLARIZED PHOTONS AND THE PRIMAKOFF EFFECT. Lapidus, L. I.; Musak-

hanov, M. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 8: 793-5(Oct. 1968). (In Russian).

It is shown that in the Primakoff effect with a polarized photon beam using the dependence of the cross section on the polarization one may experimentally discriminate the coherent photoproduction on spinless nuclei from noncoherent processes that excite the nucleus into a state with nonzero spin. Accuracy of the measurement on the η-meson life time may be improved. (auth)

7116 SEARCH FOR HEAVY LEPTONS. Gershtein, S. S.; Folomeshkin, V. N. (Serpukhov Inst. of High Energy Physics, USSR). Yadern. Fiz., 8: 768-75(Oct. 1968). (In Russian).

Various possibilities for observation of heavy leptons with the spin $\frac{1}{2}$ are discussed assuming the leptons participate in the electromagnetic and universal weak interactions only. It is noted that under these assumptions the failure of the search for heavy electron in the ep scattering does not forbid the possible existence of a heavy electron with the mass more than 500 MeV. An attempt was made to estimate the lower bound of the heavy muon mass (participating in the weak interaction with muonic neutrino or antineutrino) on the basis of the published results of the neutrino experiments in CERN heavy liquid bubble chamber. (auth)

7117 ESTIMATE OF UPPER BOUND FOR VARIOUS HYPOTHETICAL INTERACTIONS OF ELECTRONS AND PROTON ON BASIS OF THE ENERGY BALANCE OF THE SUN. Domogatskii, G. V. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 8: 759-67(Oct. 1968). (In Russian).

Possible range of coupling constants of a hypothetical zero-mass pseudoscalar meson interacting with electron and proton is discussed from basic concepts on the mechanism of energy release and transport in the sun. Existence of a pseudoscalar radiation is not in contradiction with the observed data only if the coupling constants to electron and proton satisfy the inequalities $(g_e/e)^2 \lesssim 10^{-20}$, $(g_p/e)^2 \lesssim 3 \cdot 10^{-7}$. A similar approach may be applied to estimate coupling constants for any other hypothetical radiations with electron and proton. The present approach is remarkable because the estimate of upper bound for possible coupling constants from the energy balance in the sun provides a value that is less by many orders of magnitude than the corresponding estimates based on the elementary processes. (auth)

7118 VIRTUAL-PROTON COMPTON EFFECT AND THE ELECTRON (MUON)-PROTON BREMSSTRAHLUNG AS A TEST OF QUANTUM ELECTRODYNAMICS. Greco, M. (CNEN, Frascati, Italy); Tenore, A.; Verganelakis, A. Nuovo Cim., 58A: 743-67(Dec. 21, 1968).

The virtual-proton Compton effect is studied in the approximation of a single virtual proton and a 3-3 resonance. The computation of the latter intermediate state is carried out in the framework of isobaric formalism. The contribution to the measurements of the wide-angle bremsstrahlung, arising from the virtual-proton Compton terms, is given explicitly. It is shown that these contributions depend strongly on the kinematical configuration of the experiments and may change appreciably the results of pure QED in the critical region where the intermediate electron or muon is far off its mass shell. The numerical results suggest that the exponential form factor is a more reasonable one, to describe the behavior of the γNN^* vertex form factor. In addition it is pointed out that proton-polarization measurements in the wide-angle bremsstrahlung and large-angle pair-production experiments, provide one with a new important source of information about the contribution of the virtual-proton Compton effect to these processes. Polarized cross sections are explicitly calculated. (auth)

7119 WEAK RADIATIVE HYPERON DECAYS AND CURRENT ALGEBRA. Ahmed, M. A. (CERN, Geneva). Nuovo Cim., 58A: 728-42(Dec. 21, 1968).

A low-energy theorem connecting the weak radiative decays $\alpha \to \beta + \gamma$ and $\alpha \to \beta + \pi + \gamma$ is derived. By expanding in powers of the photon four-momentum the amplitude for $\alpha \to \beta + \gamma$ is expressed in terms of the nonleptonic process $\alpha \to \beta + \pi$. The decay rates and branching ratios for all possible hyperon two-body weak radiative decays are calculated. (auth)

7120 CURRENT ALGEBRA AND FORM FACTORS. Barnes, K. J. (Imperial Coll. of Science and Tech., London). Nuovo Cim., 58A: 595-600(Dec. 1, 1968).

Properties of the hadronic electromagnetic current are proposed which fall between those of the algebra of currents and the algebra of fields. The modified Cabibbo-Radicati relation is well saturated with SU_6 states to a first approximation, and an improved approximation, using data from nucleon form factors, gives the $\gamma NN^*(1236)$ dipole coupling correct to 4%. (auth)

7121 SPECTRAL SUM RULES FOR THREE-POINT FUNCTIONS AND THEIR APPLICATION TO $\pi^0 \to 2\gamma$ DECAY. Chanda, R.; Mohapatra, R. N.; Okubo, S. (Univ. of Rochester, N. Y.). Nuovo Cim., 58A: 589-94(Dec. 1, 1968).

The Lehmann-Källén representation for three-point functions involving a soft pion was derived and applied to various processes including $\pi^0 \to 2\gamma$ decay. The integrally charged-quark model is preferred but the model of Cabibbo et al. gives the incorrect sign for the matrix element of $\pi^0 \to 2\gamma$ decay. (auth)

7122 CHARGE QUANTIZATION AND NONINTEGRABLE LIE ALGEBRAS. Hurst, C. A. (Univ. of Miami, Coral Gables, Fla.). Ann. Phys. (N. Y.), 50: 51-75(Oct. 15, 1968).

The Schrödinger equation for the motion of an electric charge in the field of a magnetic monopole is examined to see how the quantization of the interaction constant follows from the requirement of rotational invariance. It is shown that the Hamiltonian can be extended to a self-adjoint operator, but the spectrum is split unless the usual quantization conditions are satisfied. The invariance domain of the generators of rotations in the Hilbert space of state vectors is also not large enough for the Hamiltonian to be essentially self-adjoint nor can the generators be integrated to give a representation of the rotation group unless the interaction constant is quantized. The problem is interpreted as the motion of a free particle on the group manifold of the rotation group and it is shown how the Schrödinger equation above is obtained if only a subspace of state vectors for this second problem is taken. This formulation is generalized to define a class of Hamiltonians which possess a symmetry group and a quantized interaction constant. The extension from the rotation group to the Poincare group is made and it is shown that the theory is Lorentz invariant but not local unless the quantized electromagnetic field is introduced. (auth)

Weak

Refer also to abstracts 7107, 7119, and 7139.

7123 (MIT-2098-486) MUON BIBLIOGRAPHY. Technical Report No. 87. Golub, Leon M.; Tsipis, Kosta M. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Oct. 1968. Contract AT(30-1)-2098. 37p. Dep. CFSTI.

A bibliography on the interactions and properties of muons covering the period 1963-1967, inclusive, is presented. (C.E.S.)

7124 (NP-17688) PHENOMENOLOGICAL LAGRANGIAN FOR NON-LEPTONIC WEAK INTERACTIONS. Note No. 172. Vanyashin, V. S. (Rome Univ. (Italy). Istituto di Fisica). May 13, 1968. 9p. Dep.

A method of obtaining the weak non-leptonic phenomenological Lagrangian is proposed. Supplemented by the postulate of one-pole approximation the method leads to a good agreement with experimental data. (auth)

7125 ASYMPTOTIC BEHAVIOR OF THE n-POINT FUNCTION AND SOME APPLICATIONS. Olesen, P. (Univ. of Rochester, N. Y.). Phys. Rev., 175: 2165-79(Nov. 25, 1968).

A generalization of the Bjorken limit (for the two-point function) to the three-point and four-point functions is given. Some general features of the asymptotic behavior of the n-point function are also discussed. These results show that in calculating the various Ward identities for the n-point function all currents are "asymptotically conserved." We derive generalized Weinberg sum rules for the three-point functions (these results can be generalized to the n-point functions). We show that the $K_L^0 - K_S^0$ mass difference (in the universal Fermi theory) is quadratically divergent. Making a saturation assumption, we calculate the coefficient of the quadratic divergency and we get a weak-interaction cutoff $\Lambda = 4$ BeV, suggesting that weak interactions are strongly nonlocal. By means of a simple power-counting argument, we find that the nth order probably behaves like $n!\,G(G\Lambda^2)^{n-1}$, and assuming that this is some kind of asymptotic expansion, we find that the series begins to blow up for $n \sim 10^4$. The arguments for this do not constitute a proof. We then study the radiative corrections to the decays $\pi \to e\nu$ and $\pi \to \mu\nu$, which involve a three-point function. We find that these decays cannot be discussed within the framework of current algebra. Finally we show that a somewhat generalized version of the Tamm-Dancoff approximation can be justified if we use our results for the n-point function. (auth)

7126 CURRENT-CURRENT INTERACTION AND CALCULATION OF THE NONLEPTONIC BARYON DECAYS. Nussinov, Shmuel (Princeton Univ., N. J.); Preparata, Giuliano. Contract No AF49(636)-1545. Phys. Rev., 175: 2180-4(Nov. 25, 1968).

Arguments are given why the nonleptonic weak interaction

should, in a quark model with neutral-vector-boson strong interaction, be calculable in terms of low-energy contributions, which can be estimated from the knowledge of semileptonic processes. Fair agreement with experiments seems to support this possibility. The suggestion is also made that this model could be very helpful in understanding many properties of electromagnetic and weak interactions. (auth)

7127 RENORMALIZATION OF THE STRANGENESS-CHANGING AXIAL-VECTOR COUPLING CONSTANTS. Chan, C. H.; Meiere, F. T. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1428. Phys. Rev., 175: 2222-4(Nov. 25, 1968).

Using the recently determined KNΛ coupling constant and the multichannel effective-range analysis of the $\bar{K}N$ system, the renormalized axial-vector coupling constants g_A^Λ for the decay $\Lambda \to p + e^- + \bar{\nu}$ and $g_{KA}^{\Sigma^-}$ for the decay $\Sigma^- \to n + e^- + \bar{\nu}$ are recalculated, using the method of Adler and Weisberger. The results $|g_A^\Lambda| = 0.77 \pm 0.1$ and $|g_{KA}^{\Sigma^-}| = 0.55 \pm 0.2$ agree well with the best-fit solution to all leptonic baryon decays based on the Cabibbo theory, but disagree with the recent experimental results from the decay angular distribution of polarized baryons. The mass-continuation problem is investigated in detail, and its effect is shown to be non-negligible. (auth)

7128 ABOUT THE DIVERGENCE OF RADIATIVE CORRECTIONS IN π_{l2} DECAY. Benfatto, G.; Nicolo, F.; Rossi, G. (Univ., Rome). Nuovo Cim., 58A: 860-4(Dec. 21, 1968).

It is shown that in $\pi^- \to l^- + \nu_e$ decay, in the limit of first-order lepton momentum, the electromagnetic renormalization of the axial-vector $\Delta S = 0$ coupling constant G_A gives $G_{AR} = \sqrt{Z_4} G_A$ (where $\sqrt{Z_4}$ is a universal divergent constant) only if some hypothesis is made on equal-time commutators. A perturbative model is explicitly constructed in which these hypotheses are not verified so that $G_{AR} \neq \sqrt{Z_4} G_A$. (L.B.S.)

7129 NONLINEAR TERMS IN THE $K \to 3\pi$ SPECTRA. Lapidus, I. R.; Dutta Roy, B. (Stevens Inst. of Tech., Hoboken, N. J.). Nuovo Cim., 58A: 681-6(Dec. 21, 1968).

A model for the low-energy pion-pion interaction, assuming the dominance of the ρ-meson and a broad ϵ "resonance" in the $I = J = 1$ and $I = J = 0$ channels respectively, is used to discuss the nonlinearity in the $K \to 3\pi$ spectra. It is found that the major nonlinearity in the reduced spectra arises from the linear term in the matrix element. (auth)

7130 K_{l3} FORM FACTORS AND STRONG SUPERCONVERGENCE. Hsu, J. P. (Univ. of Rochester, N. Y.). Nuovo Cim., 58A: 775-82(Dec. 21, 1968).

The superconvergence of a certain invariant amplitude and the corrections to the Weinberg sum rules due to nonvanishing pion and kaon masses are discussed. New sum rules for spectral functions are obtained. These sum rules are applied to calculate the K_{l3} form factors and obtain $\xi = -1.54$ for $\lambda_+ = 0$ and $\xi = -1.05$ for $\lambda_+ = 0.02$. These values of ξ are nearly constant throughout the physical region. These results are in very good agreement with the data of the polarization experiment. (auth)

Strong (General)

7131 (ISS-68/21) HIGH-ENERGY COLLISIONS AND THE SPIN DISTRIBUTION OF HADRON STATES. Matthiae, G. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). July 5, 1968. 13p. Dep.

The existence, at high-energy, of many overlapping resonant states is assumed. From the empirical spin distribution of hadron states the observed shape of diffraction peak is predicted correctly. (auth)

7132 CURRENTS AS COORDINATES IN NONRELATIVISTIC QUANTUM MECHANICS. Pardee, W. J.; Schlessinger, L.; Wright, Jon (Univ. of Illinois, Urbana). Contract No. N00014-67-A-0305-0005. Phys. Rev., 175: 2140-7(Nov. 25, 1968).

The formulation of nonrelativistic quantum mechanics using currents and densities as coordinates is investigated. A general solution for a single-particle theory is presented, and several many-body problems are discussed. (auth)

7133 POLARIZATIONS OF PARTICLES PRODUCED IN THE ESSENTIALLY INELASTIC COLLISIONS. Boreskov, K. G. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 8: 796-805(Oct. 1968). (In Russian).

In framework of the theory of complex angular momenta some properties of the polarizations of particles produced in essentially inelastic collisions are deduced. The amplitude of the two- into three-particle transition is described by a graph with two Regge poles. The spins of the particles are arbitrary. Rotational and reflectional invariance is used as well as some properties of the helicity amplitudes at low momentum transfer. Measuring angular distributions of decay products from resonances produced in such processes one can deduce about which ones of the Regge poles dominate. (auth)

7134 DIFFRACTION SCATTERING OF HADRONS AT HIGH ENERGIES AND QUARK MODEL OF ELEMENTARY PARTICLE INTERACTIONS. Akhiezer, A. I.; Rekalo, M. P. (Inst. of Physics and Tech., Moscow). Yadern. Fiz., 8: 806-13(Oct. 1968). (In Russian).

Diffraction scattering of elementary particles at high energies is considered in terms of the quark model. It is supposed that at the momenta of colliding hadrons less than 10 GeV/c, the amplitude of the antiquark-quark scattering has two diffraction peaks, as for the quark-quark scattering amplitude, it has only ground diffraction maximum. This difference causes the appearance of the second diffraction maximum in differential cross sections of the reactions, the amplitudes of which are contributed by the annihilation quark mechanism. This model is a simple scheme to settle the problem in which processes the diffraction picture is to be observed and in which is to be absent. This scheme allows one to find relations between differential cross sections in the region of the second diffraction maximum. The relations between polarization of final particles which appear in diffraction scattering are found. The behavior of polarizations of final baryons depending on the momentum transfer square as well as the signs of polarizations of final baryons in various reactions are predicted. (auth)

7135 PARTICLE SCATTERING UNDER LARGE ANGLES AT HIGH ENERGIES. Andreev, I. V.; Dremin, I. M. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 8: 814-23(Oct. 1968). (In Russian).

It is shown that the unitarity condition and the shape of the diffractional peak known from the experiment determine the elastic scattering under large angles. In some angular region the elastic scattering differential cross section decreases exponentially with $p\theta$ (p and θ are momentum and scattering angle in cms) with additional oscillations. The theoretical predictions concerning the exponent as well as period, position of zeroes and sign of the oscillations are in very good agreement with the experiment. (auth)

7136 REMARKS ON A BOOTSTRAP MODEL BASED ON DUALITY. Alessandrini, V. A. (IAEA, Trieste, Italy). Nuovo Cim., 58A: 870-5(Dec. 21, 1968).

Some remarks are made on way to perform bootstrap calculations which exploits the idea of Regge pole-resonance duality. A constraint equation on the Regge trajectory is considered in detail. (L.B.S.)

7137 COMPOSITENESS AND ELEMENTARITY IN THEORIES WITH CROSSING. Le Guillou, J. C. (CNRS, Paris. College de France, Paris). Nuovo Cim., 58A: 553-88(Dec. 1, 1968).

It is shown that in an S-matrix with crossing, criteria of compositeness based on the vanishing of renormalization constants can be applied in a consistent way, allowing a study to be made of the crucial dependence of the left-hand singularities on the degree of elementarity of the exchanged particles. Then, using both field theory and S-matrix approaches, a paradox is solved about an "impossibility," stated several times in the literature, of distinguishing between elementarity and compositeness of two baryons in two crossed channels: on the contrary, different physical interpretations are exhibited for distinct domains of the parameters values, at the boundary of which the amplitude undergoes critical change. The various cases are distinguished where each particle is either elementary or composite; when only one of these two baryons is ("chain" or "ladder") composite, its mass is always the heaviest one. Next, the $Z = 0$, strong coupling limit and reciprocal bootstrap approaches are discussed and compared in our explicit model, together with a discussion of approximations currently used in the N/D calculations. The vanishing of both Z, while keeping finite the coupling constants, implies a characteristic symmetry in the theory. (auth)

Strong (Baryon No. = 0)

Refer also to abstract 7192.

7138 THEORY OF PION–PION SCATTERING. Masuda, Naohiko (Univ. of Wisconsin, Madison). Contract No. AT(11-1)-881. Phys. Rev., 175: 2087-92(Nov. 25, 1968). (COO-881-131).

Strong-interaction dynamics is formulated on two main assumptions. The first is similar to the one used in the Regge-pole-resonance interference model, and the other is that the potentials arising from the exchange of a few dominant particles and resonances in crossed channels can be accepted physically in the low-energy regions and that the convergent high-energy behavior

of the potentials should be guaranteed by the Regge-pole theory. A long-range potential which satisfies both the low-energy and the high-energy boundary conditions stated above is introduced. The dynamical model with only Regge-pole exchange potentials (as in the new form of the strip approximation) does not produce low-energy resonance behavior as a dynamical output. It is shown that a potential which does produce the main low-energy resonance behavior as output can be constructed by an appropriate superposition of single-particle exchange potentials and Regge-pole exchange potentials according to our second assumption. Also, two other potentials arising from the large-t parts of the Mandelstam double spectral functions are defined under the first assumption. (auth)

7139 FINAL-STATE INTERACTIONS IN $\eta \rightarrow 3\pi$ AND $K_2^1 \rightarrow 3\pi$ DECAYS. Chaudhuri, R. N. (Univ. of Delhi). Phys. Rev., 175: 2066-9(Nov. 25, 1968).

A study of $\eta \rightarrow 3\pi$ and $K_2^1 \rightarrow 3\pi$ decays is made assuming that the nonconstancy of the matrix elements originates from the S- and P-wave pion-pion final-state interactions. The I = J = 0 and I = J = 1 $\pi\pi$ interactions are assumed to be dominated by the S meson (mass 700 MeV and width 400 MeV) and the ρ meson, respectively. The analysis shows that the ρ meson swamps the S meson in describing the energy spectra. The results for the energy spectra and the branching ratios are in good agreement with recent experiments. (auth)

7140 CURRENT ALGEBRA AND PHYSICAL $\pi\pi$ SCATTERING. Carbone, G. (Univ., Turin); Donini, E.; Sciuto, S.; Furlan, G. Nuovo Cim., 58A: 668-80(Dec. 21, 1968).

$\pi\pi$ scattering lengths are calculated by using current algebra and the dispersion theory of low-energy limits. The corrections to the simplest use of the PCAC assumption are evaluated supposing a sizeable s-wave $\pi\pi$ interaction schematized by the σ-particle. By using a further sum rule of superconvergence type to calculate the off-mass-shell form factor of $\sigma\pi\pi$ coupling, we obtain values for α_s, as a function of the σ mass only, which are not in disagreement with the other theoretical predictions. (auth)

7141 DETERMINATION OF PION–PION SCATTERING LENGTHS FROM K AND η DECAYS. Focardi, S.; Mandrioli, G. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cim., 58A: 639-43(Dec. 1, 1968).

Experimental data on $K \rightarrow 3\pi$ and $\eta \rightarrow 3\pi$ decays were analyzed to determine π-π scattering lengths. (L.B.S.)

Strong (Baryon No. = 1)

Refer also to abstract 7336.

7142 (NP–17681) RADIATIVE CORRECTIONS FOR THE FRASCATI EXPERIMENT ON THE ELECTROPRODUCTION OF PIONS NEAR THRESHOLD. Note No. 180. Balla, M. I.; Borgia, B.; Di Giorgio, G. V.; Giazotto, A.; Pistilli, P.; Serbassi, S. (Rome Univ. (Italy). Istituto di Fisica). July 17, 1968. 35p. Dep.

Radiative corrections are presented for e + p elastic scattering and electroproduction interactions $e + p \rightarrow e + p + \pi^0$ and $e + p \rightarrow e + n + \pi^+$. (W.H.K.)

7143 ON POSSIBLE RELATIONS BETWEEN AMPLITUDES AND BETWEEN POLARIZATIONS OF CROSS-REACTIONS FOR THE ASYMPTOTICALLY LARGE ENERGIES AND TRANSFERRED MOMENTA. Shuba, I. M.; Lend'el, A. I. (Uzhgorod State Univ., USSR). Ukr. Fiz. Zh., 13: 1654-7(Oct. 1968). (In Russian).

The possibility is stated for obtaining asymptotical equalities of differential cross sections of cross-reactions under assumptions differing from the assumptions concerning the character of behavior of "effective spatial σ and temporal σ^0 regions of interaction of particles" for the asymptotically large s, t, and u simultaneously. It is shown that the various asymptotical relations exist for polarization of recoil nucleon of πN-scattering in dependence on realization of the restrictions for σ and σ^0. It gives the possibility to identify the information revealed from the experiments on πN-scattering. (auth)

7144 QUARK INTERACTIONS AND NUCLEON FORM FACTORS. Cicuta, G. M.; Marchesini, G.; Scotti, A. (Univ. of Milan). Phys. Rev., 175: 2113-6(Nov. 25, 1968).

The natural assumption of Fermi statistics for quarks is studied in the framework of a nonrelativistic model of the nucleon as a bound state of three quarks. Quark dynamics is assumed to be dominated by a three-body attractive force. Different statistical assumptions lead to nucleon form factors (FF) which are compared with experimental date. The FF depends only on the quark mass as a free parameter. It is argued that the nucleon FF do not provide specific evidence against Fermi statistics for quarks. The possibility of Fermi statistics appears to be related to the quark mass M and is found consistent with experimental data for $M \geq 3m$ (m-nucleon mass). (auth)

7145 QUASIDIFFRACTION SCATTERING AND SELECTION RULES FOR SPIN AND PARITY. Resnick, L. (Carleton Univ., Ottawa). Phys. Rev., 175: 2185-91(Nov. 25, 1968).

The diffraction model for inelastic scattering is shown to lead to an approximate selection rule on the spin of a diffractively produced resonance. The model leads to parity selection only for a spinless incident particle. Some examples are discussed briefly. For the reaction $p + p \rightarrow p + N + \pi$, it is shown that the nucleon pole graphs cancel in the forward direction, leaving only the pion pole graph as the dominant one. (auth)

7146 APPLICATION OF REACTION MATRIX THEORY TO MESON PROCESSES. Cook, J. L. (Australian Atomic Energy Commission, Sutherland). Aust. J. Phys., 21: 769-77(Dec. 1968).

The possible application of reaction matrix theory to pion–nucleon processes is discussed. It is found that suitable boundary conditions can remove the effects of the nucleon–pion cloud, leading to the conventional R-matrix formalism. A simple dynamical channel-coupling scheme is proposed which permits full analysis of experiments. (auth)

7147 HARARI MODEL AND THE FORWARD PION NUCLEON SCATTERING AMPLITUDE. Dance, D. R. (Cavendish Lab., Cambridge, Eng.); Shaw, G. Phys. Lett., 28B: 182-5(Nov. 25, 1968).

The experimental forward pion nucleon scattering amplitude is investigated in the light of the Harari model. It is found that the two are incompatible. However, over the first three resonance regions at least, it is found that the resonances alone give a good approximation to the full amplitude. (auth)

7148 IDENTITY FOR THE CROSSING ANGLES AND THE AMPLITUDES FOR BOSON–FERMION SCATTERING. Immirzi, G. (University Coll., London). Nuovo Cim., 58A: 619-24(Dec. 1, 1968).

Some identities for crossing angles are presented and applied to the removal of the square-root singularity from the amplitudes for boson-fermion scattering. (L.B.S.)

7149 RADIATIVE PION–NUCLEON SCATTERING. Bhargava, S. C. (Univ. of Delhi). Nuovo Cim., 58A: 815-23(Dec. 21, 1968).

Current algebra in the off-mass-shell limit ($q_\pi^2 \rightarrow 0$) is used to study radiative pion-nucleon scattering. Both the pions and the photon are dispersed thus treating the pions symmetrically. The difficulty connected with gauge invariance arising because of the limiting procedure is discussed. The calculations, which are valid in the low-energy region, give results which are comparable to that of the static-model predictions. (auth)

7150 PARAMETRIZATION OF RESONANCES OCCURRING NEAR THRESHOLD. Margulies, S. (Univ. of Illinois, Chicago); Phelan, J. J. Nuovo Cim., 58A: 804-14(Dec. 21, 1968).

The importance of using the resonance formula proposed by Jackson rather than the standard Breit–Wigner form for the parametrization of resonances occurring near threshold is emphasized. Specifically, Jackson's formula is evaluated explicitly in the approximation that the resonance occurs just above threshold, and demonstrate the distortion of the resonance shape and the shift of the resonance peak away from the resonance mass. In addition, Jackson's formula is applied to the analysis of recent data on the $S^*(\sim 1070)$ enhancement, and the effects on the determination of the resonance parameters are shown. The importance of using Jackson's formula for parametrizing resonances near threshold lies not so much in the fact that it contains $(M^2 - M_0^2)^2$ rather than the usual $(M - M_0)^2$ in the denominator, but in the fact that phase space, the energy dependence of the resonance widths, and the effect of competing decay modes are explictly included. (auth)

7151 RADIATIVE CORRECTIONS TO PION–NUCLEON COUPLING CONSTANTS. Morrison, Luther Kent (Univ. of Washington, Seattle). Contract AT(45-1)-1388B. Ann. Phys. (N. Y.), 50: 6-50(Oct. 15, 1968).

The electromagnetic corrections to the π–N coupling constants are calculated by four methods. Feynman graphs, sidewise dispersion relations, sum rules, and current commutation relations. The results are explicitly shown to be gauge invariant. Only the nucleon intermediate state is considered in the Feynman approach and the dispersion relation approach, but the effect of the $N^*(1238)$ intermediate state is estimated in the commutation relation approach. The elastic electromagnetic form factors are used to cut off the integrals for the Feynman graphs and sum rules, and an ultraviolet cutoff is used in the dispersion integrals. The uses of

PCAC and quark model current–current commutators for calculating the coupling constant shifts are shown to be model dependent and to lead to a logarithmic divergence. Comparisons of the various methods are made; although numerical results do not agree, they are generally in the direction required to understand charge dependent effects in N–N scattering. (auth)

7152 REAL PART OF THE AMPLITUDE OF THE HIGH-ENERGY FORWARD K^+–PROTON AND K^-–PROTON SCATTERING. Bialkowski, G.; Pokorski, S. (Warsaw Univ.). Nuovo Cim., 58A: 768-74(Dec. 21, 1968).

The real part of the amplitudes describing high-energy forward K^+-proton and K^--proton scattering is calculated using dispersion-relation technique in such a way that the results are practically independent of the parametrization of the unphysical region. The results obtained are in good agreement with the existing experimental data; they show the existence of a large negative real part for the K^+-proton and negligibly small positive real part for the K^--proton case. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 7145 and 7220.

7153 (COO–1764-19) EFFECT OF D-STATE IN DEUTERIUM SCATTERING. Coleman, E.; Rhoades, T. G. (Minnesota Univ., Minneapolis. School of Physics). Oct. 29, 1968. Contract AT(11-1)-1704. 10p. Dep. CFSTI.

The results of the Glauber high energy approximation including double charge exchange and the deuteron D-state are compared with existing pion-deuteron and proton-deuteron data. Inclusion of the D-state is shown to transform the former interference region to a shoulder-like region in most cases. (auth)

7154 (NP–17686) FURTHER COMMENTS ON THE DESCRIPTION OF THREE-BODY ASSOCIATED PRODUCTION IN PROTON–PROTON COLLISIONS THROUGH THE ONE-BOSON-EXCHANGE MODEL. Note No. 178. Ferrari, E. (Rome Univ. (Italy). Istituto di Fisica). July 13, 1968. 26p. Dep.

The parameters of the one-boson-exchange model (including pion and kaon exchange) which has been applied in a previous work to the reactions $pp \rightarrow YKN$ are re-examined in the light of the results from a recent experiment, which presents new data on Σ production. It is found that the cutoff parameters on the momentum transfer in pion exchange must be different for Λ and Σ production. Furthermore, in the former case, the relative amounts of π and K exchange cannot be determined from experiment, provided pion exchange is assumed to be dominant. Finally, a criticism is raised about the existing estimates of resonance production in the above reactions. (auth)

7155 PION PRODUCTION IN THE PROTON–DEUTERON INTERACTION. Patnaik, P. K. (Indian Inst. of Tech., Kanpur, India). Phys. Rev., 175: 2069-74(Nov. 25, 1968).

The differential cross section for the reaction $p + d \rightarrow {}^3He + \pi^0$ has been calculated taking Born diagrams alone. The form factor for the pd ^{3}He vertex is obtained. The result is compared with the available experimental result and found to be in fair agreement. (auth)

7156 TWO-TEMPERATURE STATISTICAL MODEL OF PARTICLE SPECTRA. Wayland, J. R. (Univ. of Maryland, College Park). Phys. Rev., 175: 2106-12(Nov. 25, 1968).

The recent secondary-particle spectra from proton-proton interactions at machine energies were analyzed in the two-temperature statistical model of Wayland and Bowen to test for the independence of the c.m. longitudinal and transverse momentum distributions. Such independence is consistent with experiments. The variation of the longitudinal temperature with incident energy is considered in detail. The energy variation of the multiplicity of particles as a function of incident energy is found to be in agreement with cosmic-ray results. The parameters for fitting particle spectra are given. (auth)

7157 GLAUBER THEORY AND πd SCATTERING IN THE GeV REGION. Alberi, G. (Univ., Trieste, Italy); Bertocchi, L. Phys. Lett., 28B: 186-90(Nov. 25, 1968).

The Glauber theory is extended to include spin variables for πd scattering. The results are compared with existing experiments. (auth)

7158 SOFT-PION SCATTERING OF DEUTERONS. D'Auria, R. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin); Napolitano, E.; Soliani, G. Nuovo Cim., 58A: 644-7(Dec. 1, 1968).

An application of recent developments of current algebra to nuclear physics is discussed, with particular reference to the investigation of the corrections to the universal Weinberg formula for the scattering length of soft pions on any target. Calculations are presented for the pion scattering length on deuterons. (L.B.S.)

Particle Invariance Principles and Symmetries

General

7159 COMMUTATION RELATIONS AMONG MEMBERS OF INTERNAL-SYMMETRY MULTIPLETS. Mathews, P. M.; Jayaraman, J.; Seetharaman, M. (Univ. of Madras). Nuovo Cim., 58A: 625-7(Dec. 1, 1968).

The question of what restrictions are imposed on the commutation relations among fields belonging to some arbitrarily specified representation of an internal-symmetry group is treated. The case of SU_3 multiplets is considered. (L.B.S.)

7160 GROUP OF RELATIVISTIC INTERNAL MOTION, ITS UNITARY REPRESENTATION AND WAVE EQUATION. Takabayasi, Takehiko (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), Suppl. No. 41, 130-93(1968).

Relativistic theory of a particle involving degrees of freedom of internal motion is set up in a general way, in the viewpoint that it should be useful for the representation of hadronic states, to derive various general results. The relativistic internal motion is described by a set of primitive kinematical variables obeying certain algebra and it immediately gives rise to not only the internal Lorentz group (relativistic spin group) L^{in} but also the "group of relativistic internal motion" $G^{in}(\supset L^{in})$. Within the framework of this general theory several typical examples are concretely treated with the analysis into their physical and unphysical consequences. It includes bilocal model, spinor model, Majorana model, and the model with Dirac spinor as internal coordinates, as well as their extensions to hybrid-type models. Especially several new versions of wave equation with interesting properties are presented. Examples are (i) Special second-order wave equation on the bilocal model, yielding the ascending mass spectrum of exact 4-dimensional harmonic oscillator; (ii) Hybrid wave equation on the spinor or Majorana model, yielding a set of ascending Regge trajectories and having no spacelike solutions; (iii) Particular subsidiary condition on the hybrid spinor model, which, together with the wave equation, reproduces rigid-rotator levels relativistically, without admitting space-like solutions; (iv) New treatment of relativistic rotator model (Lorentz tetrad model) by this scheme. (auth)

Applications (Electromagnetic and Weak)

7161 CURRENT ALGEBRA AND $K^+\Lambda$ PHOTOPRODUCTION. Basu, Debabrata; Chaudhuri, R. N. (Univ. of Delhi). Phys. Rev., 175: 2075-81(Nov. 25, 1968).

The available angular-distribution data on $K^+\Lambda$ photoproduction are analyzed using partial conservation of axial-vector current (PCAC) and SU(3) × SU(3) algebra of currents. The off-shell extrapolation implicit in the use of PCAC is contained in the limit (kaon four-momentum)$^2 \rightarrow 0$ which reproduces the dynamical singularities of the amplitude in detail. The results of the calculation show reasonable agreement with experiment at low energy. The behavior of the angular distribution at high energy is also discussed. (auth)

7162 PHENOMENOLOGICAL ANALYSIS OF WEAK-RADIATIVE DECAY OF THE K^+ MESON AND CP-NONINVARIANT EFFECTS. Singh, Y. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 175: 2214-21(Nov. 25, 1968).

A phenomenological analysis of the pion and the photon energy spectra and the photon-pion angular correlation spectrum in the weak-radiative decay, $K^+ \rightarrow \pi^+ + \pi^0 + \gamma$, is performed by parametrizing the direct electric (E1) and magnetic (M1) dipole transition amplitudes. A comparison of the calculated π^+ energy spectrum with the experimental spectrum (together with the qualitative information available from the theoretical investigations of the direct amplitudes) makes it possible to put limits on the direct amplitudes. We also make an estimate of the maximum asymmetry in the weak-radiative decays of K^+ and K^- mesons that could be present because of possible CP noninvariance in these decays. This estimate is based on a model in which CP noninvariance arises from a relative phase (other than $\pi\pi$ scattering phase shifts) between the inner bremsstrahlung and the E1 amplitudes. The maximum observable asymmetry in the K^+ and K^- radiative decay rates would be about 25%. (auth)

7163 STRESS-TENSOR-CURRENT COMMUTATORS, ELECTORMAGNETIC AND WEAK CORRECTIONS TO CURRENT COMMUTATORS, AND SUM RULES. Jackiw, R. (CERN, Geneva. Harvard Univ., Cambridge, Mass.). Phys. Rev., 175: 2058-65 (Nov. 25, 1968).

Equal-time commutation relations between selected components of the energy-momentum tensor and selected components of a current, arising from internal transformations, are derived in a model-independent fashion. These commutators are then used to establish the following three results: (1) It is shown that current-current commutators do not have the standard form in the presence of electromagnetic and weak interactions. Specifically, it is demonstrated that the space components of an isospin current do not transform as isospin vectors. (2) Weinberg's second sum rule is shown to follow from further assumptions about our commutators, and it is argued that kaon mass corrections must be expected in the SU(3) × SU(3) generalization of this sum rule. (3) A relation between decay constants in broken SU(3) × SU(3) is established. It is $F_\pi\mu_\pi^2 + F_K\mu_K^2 = F_\eta\mu_\eta^2$. (auth)

7164 ELECTROMAGNETIC INTERACTIONS OF BARYONS IN DYNAMICAL GROUP THEORY. Corrigan, Dennis. Boulder, Colo., Univ. of Colorado, 1968. 203p.

Thesis.

Dynamical group theory is used to provide a framework for computation of electromagnetic properties of hadrons and hadron resonances. The theory makes use of purely algebraic methods only. Several models are investigated as illustrations of the general theory. The most successful model is one which uses O(4,2) as the dynamical group. Nucleon electromagnetic form factors are predicted in excellent agreement with experiment. Transition form factors to excited states N* are also calculated with this model and the predictions are compared with the small amount of experimental data presently available. In a second model, based on O(4,2), the consequences of the assumption of the dominance of the electromagnetic current by neutral vector mesons is investigated. Both elastic and inelastic form factors are computed and an estimation is given of certain inelastic contributions to the neutron-proton mass difference. Finally, the problem of the inclusion of internal symmetries is examined in some detail. Two models which incorporate internal symmetries are described. The first uses the group O(4,2) ⊗ SU(3) in the rest frame and seems to be the most reasonable way to include SU(3). The other model is based on the dynamical group SU(4,4); this model is not in such good agreement with experiment. (Disser. Abstr.)

Applications (Strong)

Refer also to abstract 7188.

7165 (IC-68/88) IMPLICATIONS OF THE O(4,2) MODEL OF STRONG INTERACTIONS FOR REGGE POLE AND HIGH-ENERGY PHENOMENOLOGY. Barut, A. O. (International Centre for Theoretical Physics, Trieste (Italy)). Sept. 1968. 24p. (CONF-680927-1). Dep.

From Conference on Hadron Spectroscopy, Keszthely, Hungary.

Linear Regge trajectories, secondary trajectories, form factors and their relation to high-energy hadron scattering are consequences of the O(4,2) model of strong interactions. The O(4), O(2,1) and the two distinct SL(2,C) classifications of trajectories used at present, as well as the exchange degenerate trajectories, are all given by the subalgebras of the O(4,2). (auth)

7166 (NP-17684) LOWER HADRON STATES CLASSIFICATION AND SU(3)⊗SU(3) CHIRAL ALGEBRA APPROXIMATE SATURATION. Note No. 177. Buccella, F.; De Maria, M.; Tirozzi, B. (Rome Univ. (Italy). Istituto di Fisica). July 10, 1968. 20p. Dep.

A classification scheme for hadrons is proposed, which fits well with the experimental π-N resonances. Under the hypothesis of SU(3) ⊗ SU(3) chiral algebra approximate saturation, G_A and $\alpha = D/D + F$ are evaluated in terms of the squares of the axial coupling constants; their value is in good agreement with experiment. Further model dependent predictions are obtained for the mixing angles of the baryon wave function and for the branching ratios of the predicted strange resonances. The values of the mixing angles are in agreement with those expected from the e.m. structure of the nucleons. (auth)

7167 BEHAVIOR OF CURRENT DIVERGENCES UNDER $SU_3 \times SU_3$. Gell-Mann, Murray (California Inst. of Tech., Pasadena); Oakes, R. J.; Renner, B. Contract AT(11-1)-68. Phys. Rev., 175: 2195-9(Nov. 25, 1968).

The behavior under $SU_3 \times SU_3$ of the hadron energy density and the closely related question of how the divergences of the axial-vector currents and the strangeness-changing vector currents transform under $SU_3 \times SU_3$ are investigated. It is assumed that two terms in the energy density break $SU_3 \times SU_3$ symmetry; under SU_3 one transforms as a singlet, the other as the member of an octet. The simplest possible behavior of these terms under chiral transformation is proposed: They are assigned to a single $(3,3^*) + (3^*,3)$ representation of $SU_3 \times SU_3$ and parity together with the current divergences. The commutators of charges and current divergences are derived in terms of a single constant c that describes the strength of the SU_3-breaking term relative to the chiral symmetry-breaking term. The constant c is found not to be small, as suggested earlier, but instead close to the value $(-\sqrt{2})$ corresponding to an $SU_2 \times SU_2$ symmetry, realized mainly by by massless pions rather than parity doubling. Some applications of the proposed commutation relations are given, mainly to the pseudoscalar mesons, and other applications are indicated. (auth)

7168 CHIRAL SYMMETRY. Shiozaki, T. (Nagoya Univ., Japan). Nuovo Cim., 58A: 853-9(Dec. 21, 1968).

A simple method to construct the effective Lagrangian which is invariant under the chiral $U_3 \times U_3$ group is presented. The method uses nonlinear chiral transformations and it clarifies the relation between linear and nonlinear chiral symmetries. The chiral transformations of pseudoscalar nonet fields and general octet fields are discussed. (L.B.S.)

Field Theories

Quantum Field Theory

Refer also to abstract 7118.

7169 (DESY-68/55) VALIDITY OF QUANTUM ELECTRODYNAMICS AT EXTREMELY SMALL DISTANCES. Alvensleben, H.; Becker, U.; Bertram, William K.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany). Massachusetts Inst. of Tech., Cambridge). Oct. 1968. 9p. Dep.

The yield of electron-positron pairs from the reaction γ + carbon → $e^+ + e^-$ + carbon was measured as a test of the validity of quantum electrodynamics (Q.E.D.) at very small distances. The results show that first order Q.E.D. correctly predicts the e^+e^- pair yield up to an invariant pair mass of 900 MeV/c^2. (auth)

7170 TRANSFORMATION PROPERTIES AND RELATIVISTIC EQUATIONS FOR SPIN-ONE ELEMENTARY SYSTEMS. Fonda, L.; Ghirardi, G. C. (Univ., Trieste, Italy. Nazionale di Fisica Nucleare, Trieste, Italy). Phys. Rev., 175: 2082-6 (Nov. 25, 1968).

A compact procedure is introduced to go from wave functions transforming according to the irreducible representations of the Poincaré group describing spin-one particles to four-vector functions. The derivation of the Proca and Maxwell equations is also given. (auth)

7171 ASYMPTOTIC PROPERTIES OF WAVE FUNCTIONS AND FORM FACTORS OF RELATIVISTIC BOUND STATES. Amati, D.; Caneschi, L.; Jengo, R. (CERN, Geneva). Nuovo Cim., 58A: 783-803(Dec. 21, 1968).

The asymptotic behavior of form factors of hadrons considered as bound states (i.e., Reggeized hadrons) is studied in a ladder Bethe-Salpeter model. The asymptotic properties of the B.S. wave function are first investigated by reducing the problem to a system of a Fredholm plus a Volterra-like integral equation. The form factors turn out to be bounded by inverse powers of k^2 (times some powers of log k^2) for large values of the square momentum transfer k^2. For spin 0 and ½ bound states a dipole bound (i.e., $1/(k^2)^2$ disregarding log k^2) is obtained while for higher integer spin J the form factors decrease at least as $1/(k^2)^{J+2}$. (auth)

7172 AN EXTENDED LEE MODEL WITH INDEFINITE METRIC. Chen-Tsai, C. T. (Tsing Hua Univ., Taiwan). Nuovo Cim., 58A: 687-700(Dec. 21, 1968).

The question on the existence of a physical Hilbert subspace in a field theory with indefinite metric is investigated in an extended Lee model. The interaction Hamiltonian of the original Lee model is generalized to contain an infinite set of terms representing the basic interaction processes, $V + n\theta \longleftrightarrow N + (n+1)\theta$, $n = 1, 2, 3, \ldots$, besides the usual trilinear term. The bare field operators are transformed into "clothed" field operators according to the unitary clothing transformations of Greenberg and Schweber, so that the conditions for separating out the "ghost" states are easily sought. It is found that a physical Hilbert subspace exists in this model provided that the cut-off functions introduced have certain special forms. (auth)

7173 FIELD-THEORETIC FORMULATION OF THE BOOTSTRAP THEORY. Englert, F. (Univ. Libre, Brussels); Brout, R.; Stern, H. Nuovo Cim., 58A: 601-18(Dec. 1, 1968).

It is shown that it is possible to find a completely consistent bootstrap (all hadrons are bound states of all hadrons) using conventional field theoretic techniques in an unconventional limit. This latter is the limit wherein all interactions are set to zero, as well as all elementary single-particle propagators. The hadrons are then described by poles in infinitely composite propagators. (auth)

7174 FIELD THEORY OF ELEMENTARY DOMAINS AND PARTICLES. II. Katayama, Yasuhisa; Umemura, Isao; Yukawa, Hideki (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), Suppl. No. 41, 22-55(1968).

Formulation and its consequences of the theory outlined in the preceding paper are presented and analyzed. The field is defined on the closed domain in the space-time world and is described by fourteen variables, i.e., by the coordinates of the center, invariant deformable lengths and generalized four-dimensional Euler angles. The combination of six Euler angles and two invariant lengths gives a complex four-component spinor operator by which the eigenstates of internal spin are determined. The fundamental field equation is introduced based on a simple geometric consideration of periodicity among the elementary domains and analyzed on a line similar to the infinite component theory. Also the second quantization is discussed mainly in connection with the finite difference character of the field equation and the simultaneous preparation of the four-dimensional elementary domains in the four-dimensional manifold is assured from the commutability of the fields of domains separated by a finite distance in space-like and time-like directions. A possibility of introducing the internal symmetry such as SU(6) is also suggested in connection with possible choice of the four invariant lengths to be amalgamated in constructing the spinor operators. The interaction scheme in this theory is only sketched and left to future investigations. (auth)

7175 FIELD THEORY OF ELEMENTARY DOMAINS AND PARTICLES. I. Katayama, Yasuhisa; Yukawa, Hideki (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), Suppl. No. 41, 1-21(1968).

A brief historical account was given on the developments in an effort to construct a unified theory of elementary particles based on the assumption that each particle is a quantum mechanical object extended in space and time. As the most simple model, essential features of bilocal field theory are discussed first. Generalization to multilocal field and the derivation of various quantum numbers, which are ascribed to hadrons, from the quantization of internal motion are described. To the models based on multilocal field theory, geometrical constraint is imposed, for the purpose of obtaining half integer spin states as well as integer spin states. Similarity of such a case to the continuous deformable body subject to quantization is pointed out. The concept of elementary domain is introduced as a natural consequence of treatment of system of many extended particles according to the method of second quantization in nonrelativistic theory. Relativistic theory of elementary domains is then developed. Elementary particles are interpreted as sequences in time of the excited states of the four-dimensional elementary domain which is regarded as a quantum mechanical object. As the substitute for Schrödinger wave equation in quantum mechanics of point particles, a new type of wave equation, which connects elementary domains separated by a finite amount from each other in space and time, is proposed. It is essentially a difference equation with respect to the displacement of the center of the domain. Multiplicity of the solutions of this difference-type equation gives rise to a new feature which seems to open a way hitherto unknown toward the solution of the problem of convergence. (auth)

Gravitation and General Relativity

7176 EVOLUTION OF PETROV TYPES OF SPACES IN GENERAL RELATIVITY. Case, Lloyd Allen. Provo, Utah, Brigham Young Univ., 1968. 90p.

Thesis.

A theoretical study is made of the evolution of one Petrov type of space-time into another (Evolution meaning the change of the Petrov type a point observer would consider his local space-time). This study is motivated by a desire to increase the present understanding of this invariant classification and thereby improve its use as a tool for understanding solutions to the field equations of general relativity. The study happens to involve a detailed consideration of discontinuities in space-times. From this study an algorithm is developed that may be used to test the evolution of any closed form solution of interest. An example of its use is included. Also a flow diagram is found which indicates into which type any particular type may evolve and the necessary form of the discontinuity causing that change. During the development, several additional results are reached. Clarification of the distinction between gravitational waves and a space-time's Petrov type is found. The study of discontinuous hypersurfaces is found essentially equivalent to Trautman's information approach to waves, and seems to give better motivation for its results. The Weyl technique is understood to be an important method for separation of coordinate and physical behaviors. (Disser. Abstr.)

7177 GRAVITATION WITHOUT SELF-INTERACTION. Deser, S.; Laurent, B. E. (Brandeis Univ., Waltham, Mass.). Ann. Phys. (N. Y.), 50: 76-101(Oct. 15, 1968).

The possibility that the gravitational field is a linear spin-two field is explored. As is well-known such a field must have a divergence-free source. But when matter interacts with the gravitational field, its stress tensor is not divergence-free and therefore cannot serve as the source. Instead, a divergence-free, nonlocal, projection of the matter stress tensor is chosen. It is shown that it gives the same predictions as general relativity in all experimental and observational tests made so far; it is in fact difficult to decide, experimentally, between the two theories. Conceptually there are basic differences. The principle of equivalence is fulfilled for matter but not for gravitons, which are "uncharged," like photons in electrodynamics. There are indications that gravitational collapse does not occur. The theory may be written in local form, using auxiliary fields; these correspond to an additional spin-zero excitation (with positive-definite energy). (auth)

7178 REMARKS ON A CLASS OF ALMOST TRIVIAL SOLUTIONS OF THE GRAVITATIONAL FIELD EQUATION. Kraus, K. (Univ., Marburg, Ger.). Ann. Phys. (N. Y.), 50: 102-5(Oct. 15, 1968).

A class of static solutions of Einstein's vacuum field equation $R_{ik} = 0$ is described. The solutions are locally flat, but possess line singularities and global space curvature. Being analogous to the electromagnetic field of an infinitely long and infinitely thin solenoid, they give rise to gravitational analogues of the Aharonov–Bohm effect. Furthermore, they provide examples for a conjecture on asymptotic global flatness. (auth)

7179 EQUATIONS OF MOTION IN AN INTERNAL FIELD WITH CENTRAL SYMMETRY IN THE GENERAL THEORY OF RELATIVITY. Stanyukovich, K. P. Dokl. Akad. Nauk SSSR, 182: 326-9(Sept. 11, 1968). (In Russian).

The equation of motion in the general theory of relativity becomes simplified if r and the second coordinate m, serving as Lagrangian coordinates, are used as independent variables. The fundamental equations are derived from the conservation laws. The calculations yield a system of only 3 first-order quasilinear equations; for isentropic processes, when the entropy is constant, only 2 equations are involved. Boundary transitions allow the derivation of an equation which corresponds to the special theory of relativity and under certain conditions a transition to Newton's theory is obtained. The equations derived are the simplest ones for analyzing spherically symmetric motions in the general theory of relativity. (TTT)

Scattering Theory

Refer also to abstracts 7135, 7145, 7351, and 7352.

7180 (NP–17689) MINIMAL SOLUTIONS TO THE CONSPIRACY PROBLEM AND CLASSIFICATION OF REGGE POLE FAMILIES. Note No. 171. Di Vecchia, P.; Drago, F.; Paciello, M. L. (Rome Univ. (Italy). Istituto di Fisica). May 10, 1968. 11p. Dep.

A non group-theoretical approach to the conspiracy problem, based on analyticity, crossing symmetry and factorization, is presented. The solutions to all the physically interesting cases are given. A classification of Regge pole families is deduced. The results are in agreement with those obtained in the group theoretical approach. (auth)

7181 RELATIVISTICALLY INVARIANT EXPANSION OF HELICITY SCATTERING AMPLITUDE. Verdiev, I. A. (Inst. of Physics, Baku). Zh. Eksp. Teor. Fiz., 55: 1773-83(Nov. 1968). (In Russian).

An expansion of the single-particle helicity state is obtained in terms of states which transform with respect to the irreducible unitary representation of the homogeneous Lorentz group. A similar expansion is performed for a two-particle spiral state in the center-of-inertia system. A relativistically invariant expansion of the helicity scattering amplitude is given. The threshold behavior of the partial amplitude is obtained. (auth)

7182 NEW PROOF OF THE POMERANCHUK THEOREM. Lomsadze, Yu. M.; Kontrosh, E. E.; Tokar, S. S. (Uzhgorod State Univ., USSR). Ukr. Fiz. Zh., 13: 1701-5(Oct, 1968). (In Russian).

On the basis of a modified theorem of Meiman a new proof is presented of the Pomeranchuk theorem provided the amplitude difference $A_+(E) - A_-(E)$ grows slower than E ln E. In contrast to the proofs of this theorem already available, no additional mathematical assumption is used besides the absence of highly strong oscillations $\Delta\sigma = \sigma_+(E) - \sigma_-(E)$ in a clearly formulated sense. It is taken into account in particular, that the amplitudes $A_\pm(E)$ with real E are not ordinary but generalized functions. Two other formulations of the Pomeranchuk theorem are presented, one of which still more weakens limitation of possible oscillations of $\Delta\sigma(E)$, and the other contains no limitations of these oscillations at all. (auth)

7183 PHYSICAL REGION ON THE PLANE OF TWO INVARIANT MOMENTUM TRANSFERS FOR A REACTION WITH THREE PARTICLES IN THE FINAL STATE. Kajantie, K.; Lindblom (Univ. of Helsinki). Phys. Rev., 175: 2203-13(Nov. 25, 1968).

The boundary of the kinematically allowed region on the plane of two invariant momentum transfers of a reaction with three particles in the final state is derived and the phase-space distribution in this region determined. The boundary may in the most general case consist of branches of a complicated curve, a parabola, and two straight lines. Applications to the analysis of doubly peripheral reaction mechanisms are discussed. (auth)

7184 STRUCTURE OF UNITARY SCATTERING AMPLITUDES. II. Martin, Arthur W. (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev., 175: 2155-65(Nov. 25, 1968).

A representation for the invariant scattering amplitude A(s,t,u) is constructed that satisfies elastic unitarity in the s channel. The development is based upon the usual fixed-s dispersion relations and rigorous expansions of the partial-wave amplitudes. The amplitude has the singularity structure of the Mandelstam representation and leads to new expressions for the double spectral functions in the elastic region. The relationship of resonances to the Mandelstam representation is clarified. The continuation of the unitary scattering amplitude to the inelastic region and the physical regions of the crossed channels is discussed. (auth)

7185 ANALYTICITY AND THE DAUGHTER STRUCTURE OF CONSPIRING REGGE-POLE FAMILIES. Jones, Lorella (California Inst. of Tech., Pasadena); Shepard, Harvey K. Contracts AT(11-1)-34; AT(11-1)-68. Phys. Rev., 175: 2117-40 (Nov. 25, 1968).

By studying reactions involving unequal-mass particles with spin, we show that much of the structure of possible families of conspiring Regge poles follows simply from imposing the $t = 0$ analyticity constraints. These requirements imply the necessity for both daughter and conspirator contributions, where in many cases the daughter poles are themselves conspirators. We discuss the pattern of ($t = 0$) singularity cancellation by daughter trajectories in both the single-parity families and double-parity families for general mass and spin processes and demonstrate that the two have rather different structure. As an application, the reactions $\pi\pi \to VV$, $\pi N \to VN$, and $NN \to NN$ are examined in detail from the point of view of analyticity constraints. We show that in all cases factorization of the (first) daughter residues is consistent with the required analyticity properties of the amplitudes, and that in certain (nonevasive) cases the factorization of the daughter residues is directly implied by factorization for the leading pole when the conspiracy constraints are obeyed. We conclude that our results, based on analyticity (and factorization), complement the group-theoretic O(4) classification; the symmetry and analyticity methods give similar information when they overlap, but supplement each other in certain cases when one method is not readily applicable. (auth)

7186 CROSSING-SYMMETRIC RISING REGGE TRAJECTORIES. Chu, Shu-yuan (Univ. of California, Riverside); Epstein, Gary; Kaus, Peter; Slansky, Richard C.; Zachariasen, Fredrik. Contracts AT(11-1)-68; AT(11-1)-34. Phys. Rev., 175: 2098-2105(Nov. 25, 1968).

Corrections due to the exchange of the resonances lying on the leading crossed-channel Regge trajectory are calculated for a linearly rising Regge trajectory in a single-channel, single-trajectory model. The corrections are small, and the equations force no restriction on the slope or intercept of the trajectory. The integral equations for the Regge parameters are derived, and detailed numerical results for the ρ trajectory are given. A method for determining the slope of the trajectory is proposed. (auth)

7187 THRESHOLD BEHAVIOR OF PARTIAL-WAVE DISPERSION RELATION AND SHORT-RANGE FORCE. Masuda, Naohiko (Univ. of Wisconsin, Madison). Contract No. AT(11-1)-881. Phys. Rev., 175: 2093-8(Nov. 25, 1968). (COO–881-169).

In a paper on existence of a ghost-free solution of the unsubtracted partial-wave dispersion relation, Frye and Warnock conjectured that the positive-definite value at threshold of the unitarity integral on the physical region must be canceled by the short-range force (i.e., multiparticle-exchange contribution) arising from the first and second double spectral functions in order to guarantee the required p wave and higher threshold behavior. This conjecture is examined explicitly in an unsubtracted dispersion relation for the $I = l = 1$ pion-pion scattering amplitude. With certain choices of the ρ Regge parameters, it is shown in the approximation scheme that this conjecture is nearly satisfied, and one can conclude that the so-called subtraction constant or threshold factor which is usually arbitrarily introduced to correct the threshold behavior could be expressed in terms of known physical quantities. However, with some other choice of ρ Regge parameters, the numerical result shows that this conjecture is not satisfied by the one-ρ-Regge-pole approximation and indicates a need for additional Regge poles or Castillejo-Dalitz-Dyson poles. (auth)

7188 ANALYTICITY AND BROKEN O(4) SYMMETRY. Bronzan, J. B.; Jones, C. Edward; Kuo, P. K. (Massachusetts Inst. of Tech, Cambridge). Contract AT(30-1)2098. Phys. Rev., 175: 2200-3(Nov. 25, 1968).

The extent to which broken O(4) results can be obtained by requiring that unequal-mass scattering amplitudes be analytic at zero energy is investigated. All O(4) constraints upon the trajectory functions can be obtained in this way. (auth)

7189 LOWER LIMIT OF THE ELASTIC SCATTERING AMPLITUDE AT FIXED MOMENTUM TRANSFER. II. Baluni, Varuzhan; Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.), 8: 122-3 (Aug. 20, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 122-3(Aug. 20, 1968).

It was shown in an earlier paper by one of the authors that the rigorously proved analytic properties of the imaginary part A(s,t) of the elastic-scattering amplitude makes it possible to obtain the lower limit of this amplitude in a certain momentum-transfer interval $-\gamma < t < 0$. The results obtained are generalized, and a lower limit is established that is valid for all finite $t < 0$. (auth)

7190 ON THE THRESHOLD BEHAVIOR IN THE FROISSART'S N/D METHOD. Chermalykh, G. N. (Gas Inst., Kiev). Yadern. Fiz., 8: 824-6(Oct. 1968). (In Russian).

The inelasticity function introduced by Froissart is modified so as to provide the correct threshold behavior for the partial-wave amplitude obtained by the Froissart's N/D method. (auth)

7191 TWO-DIMENSIONAL EXPANSIONS OF RELATIVISTIC AMPLITUDES, REGGE TRAJECTORIES, AND DAUGHTER POLES. Winternitz, P.; Smorodinskii, Ya. A.; Sheftel, M. B. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 8: 833-46 (Oct. 1968). (In Russian).

Properties of integral relativistic expansions in the hyperbolic coordinate system are investigated. Relation of the expansion for the forward scattering amplitude to the Toller's expansion and to the appearance of the daughter poles is established. Possibilities for the Regge poles to appear are discussed. (auth)

7192 MASS FORMULAE FROM REGGE-TRAJECTORY CONSTRAINTS IN THE VENEZIANO MODEL. Costa, G. (Instituto de Fisica Teorica, Sao Paulo, Brazil, Univ., Padua, Istituto Nazionale di Fisica Nucleare, Padua); Zimerman, A. H. Nuovo Cim., 58A: 865-9(Dec. 21, 1968).

A model for relativistic scattering amplitude was recently proposed in which crossing symmetry and Regge asymptotic behavior are ensured by the requirement of linearly rising trajectories. The scattering amplitude exhibits Regge poles in families of parallel trajectories with residues in definite ratios, and satisfies generalized superconvergence relations. The implication of the model when applied to different processes is discussed, and it is shown how the constraints imposed on the Regge trajectories give rise to mass relations. (L.B.S.)

7193 PHASE OF AMPLITUDES AT ZERO SCATTERING ANGLE. Mickens, R. E. (Vanderbilt Univ., Nashville). Nuovo Cim., 58A: 848-52(Dec. 21, 1968).

Expressions are given for the phase of the scattering amplitude in the forward direction for certain inelastic reactions. Data on

the phase for these reactions will provide information on the importance of branch points in the angular-momentum plane. (auth)

7194 RELATIVISTIC TWO-BODY SCATTERING. Brett, A. M.; Okolowski, J. A. (Drexel Inst. of Tech., Philadelphia). Nuovo Cim., 58A: 824-34(Dec. 21, 1968).

Relativistic two-body scattering is treated using the Klein–Gordon equation which admits positive-energy solutions only. The total scattering cross section is expressed in terms of phase shifts, which are in turn related to the inter-particle potential. A direct calculation of the cross section, employing a method due to Dirac, is also given. These two methods are applied to the case of a δ-function potential. (auth)

7195 POLE APPROXIMATION IN POTENTIAL SCATTERING. Morawitz, H. (IBM Research Lab., San Jose, Calif.). Ann. Phys. (N. Y.), 50: 1-5(Oct. 15, 1968).

A simple approximation for calculating S-wave scattering in potential theory at certain discrete energies $E^{(\alpha)} = (\phi_\alpha, H\phi_\alpha)$, with $\phi_\alpha(r)$ a suitable function vanishing as $r \to \infty$, is proposed. It corresponds to replacing the right hand branchcut in the scattering amplitude due to unitarity by a simple pole at $E = E^{(\alpha)}$ and places scattering on the same footing as the bound state problem. Numerical results for the attractive exponential and Yukawa potential are given. (auth)

7196 DERIVATION OF THE HIGH-ENERGY UPPER BOUNDS OF RELATIVISTIC AMPLITUDES AT FIXED ANGLES ($\neq 0, \pi$). Chadan, K. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim., 58A: 632-8(Dec. 1, 1968).

The high-energy fixed-angle upper bound of relativistic elastic scattering amplitude of two scalar neutral particles of equal mass is derived, using Mandelstam's assumptions and a modification of the Omnès's representation. (L.B.S.)

7197 NOTE ON THE ANALYTIC CONTINUATION OF THE SCATTERING AMPLITUDE. Viano, G. A. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa). Nuovo Cim., 58A: 628-31(Dec. 1, 1968).

A probabilistic approach to the problem of extrapolation of scattering amplitudes is discussed. Conditions are formulated under which the extrapolation problem can be regularized, which allows approximate solutions to be constructed which depend on the scattering data. A theorem on the analytic-continuation problem is established and proved. (L.B.S.)

7198 GENERALIZATION OF THE DISTORTION OPERATOR METHOD. Michalik, B. (Inst. of Plasma Physics, Prague). Ann. Phys. (N. Y.), 50: 106-27(Oct. 15, 1968).

A set of new objects is introduced into the theory, the nth term of which is called "the distortion operator of nth kind." The distortion operator of 0th kind is identical to the transition (or reaction) operator, the distortion operator of 1st kind is the previously introduced distortion operator. Equations for the new operators are deduced and shown to be nonsingular for all $n \geq 1$. The radius and speed of convergence of the Neumann series following from these equations increase with increasing n. The transition and reaction operators are expressed in terms of the distortion operator of the nth kind; in the first approximation of the second distortion approach, unitarity is satisfied (as well as in the first order of the first distortion approach). In the partial-wave momentum representation, separable approximations of a given interaction are then obtained. Finally, the convergence when going from the first to the second distortion approach is tested and found to be very rapid. (auth)

Particle Accelerators

Refer also to abstracts 6533 and 7281.

7199 (AECL-3190) INTENSE NEUTRON GENERATOR AND FUTURE FACTORY TYPE ION ACCELERATORS. Lewis, W. B. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1968. 8p. (DL-94; CONF-681017-13). Dep. CFSTI. CAN $0.50.

From 15th Nuclear Science Symposium, Montreal, Canada.

A neutron factory is likely to sell its product in the form of isotopes. Today neutron factories are nuclear reactors. Ion accelerators may also produce isotopes by direct interaction and, at high enough energies, mesons and hyperons. The challenge of the electrical production of neutrons goes far beyond the isotope market. It challenges the two popular concepts for long term large scale energy, the fast breeder reactor and controlled thermonuclear fusion. For this use about 4% of nuclear generated power would be applied in a feedback loop generating extra neutrons. Competition rests on operating and processing costs. The Intense Neutron Generator proposal now cancelled would have been full scale for such a use, but much further advance in accelerator engineering is required and anticipated. Perhaps most promising is the application of the ion drag principle in which rings of fast electrons are accelerated along their axis dragging ions with them by electrostatic attraction. Due to the much larger mass of the ions they can acquire much higher energy than the electrons and the process could be efficient. Such accelerators have not yet been made but experimental and theoretical studies are promising. (auth)

7200 (BNL-13019) 60-Hz FLUX PUMPS. Britton, R. B. (Brookhaven National Lab., Upton, N. Y.). [nd]. 4p. Dep. CFSTI.

The design and operating characteristics of a flux pump, which operates from 60 Hz, are described. (B.G.D.)

7201 (JINR-P9-4102) CALCULATION OF THE EXTRACTION SYSTEM FOR SYNCHROCYCLOTRON. Danilov, V. I.; Mukhina, V. B.; Polferov, E. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 40p. (In Russian). Dep.

The method for calculation of the extraction efficiency is proposed. The calculations were made for the system consisting of the nonlinear regenerator and the hard focusing magnetic channel. Numerical calculations of the initial equations were made with the help of the computer. It is shown that the particle losses are determined by the acceptance of the magnetic channel and the shape of the regenerator field. Determining parameters of the magnetic channel are the field gradient of the second section and the thickness of the front plate. The chosen regenerator is of such a kind that fulfills the condition of correlation of the radial beam emittance with the magnetic channel acceptance. (auth)

7202 (JINR-P9-4135) FOCUSING OF CHARGED ELECTRON RING IN THE COLLECTIVE ION LINEAR ACCELERATOR. Bonch-Osmolovskii, A. G.; Dolbilov, G. V.; Ivanov, I. N.; Perel'shtein, E. A.; Sarantsev, V. P.; Yarkovoi, O. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 10p. (In Russian). Dep.

Problems of charged electron ring focusing in the collective ion linear accelerator are discussed. Three types of focusing are considered: focusing of the azimuthal component of the magnetic field, focusing by counter waves and focusing by the image forces. The conditions of the stability of the electron oscillations in the ring are obtained and the possibilities of applying the above-mentioned types of focusing are determined. (auth)

7203 (TID-24773) NATIONAL ACCELERATOR LABORATORY DESIGN REPORT. (National Accelerator Lab., Batavia, Ill.). July 1968. 307p. Dep. CFSTI.

After a brief introduction of the purpose and character of the National Accelerator Laboratory, a detailed description of the accelerator is presented. Other topics discussed are the provisions for experimental use, physical plant, costs and schedules and provisions for future expansion. (B.G.D.)

7204 (TID-24800) ON THE RF BUNCH TIGHTENING. Larsen, F.; Prelec, K. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Oct. 22, 1968. Contract AT(30-1)-2137. 8p. Dep. CFSTI.

The adiabatic theorem is applied to phase oscillations in a synchrotron for estimating the bunch length (phase amplitude) and energy spread (radial amplitude) during the process of bunch tightening. Total acceptance and adiabatic changes of parameters are also discussed. (W.H.K.)

7205 IRRADIATION TABLE FOR AN ELECTRON ACCELERATOR. Toi, A. (to Matsushita Electric Industrial Co., Ltd.). Japanese Patent 1968-13836. June 12, 1968. Filed Apr. 9, 1964.

A method is proposed where many samples can be irradiated with electron rays from an accelerator in a simple manner. It consists of an electric motor; a rotating vertical axis, driven by the motor, which can rotate at different speeds and right- or left-handed; and, radial blades, extending horizontally from the top end of the rotating axis, in the manner of a windmill (most part of the blade is of a net). The irradiation of samples on the net blades can be done either while in continuous rotation, or as each blade is stopped for an interval of time. (NSA of Japan)

7206 METHOD FOR CONTROLLING THE INTENSITY OF A CHARGED-PARTICLE BEAM BY LIGHT-COMBINED CONVERSION. Suga, Yoshio (to Inst. of Physics and Chemical Research). Japanese Patent 1968-18320. Aug. 2, 1968. Filed June 1, 1964.

A method is proposed so that the use of transformers etc. with high resistance can be eliminated. A variety of the complicated controls are possible. An electrical signal with which a charged-particle beam is to be controlled, is converted to light in a suitable

device through a modulator. This light is received at a suitable device where it is converted back to the electrical signal. The charged-particle beam is controlled by sending this electrical signal to the electron-gun control grid (in the electron-ray working apparatus). (NSA of Japan)

7207 X-RAY GENERATING DEVICE IN THE BETATRON. Hattori, Hiroyuki (to Shimadzu Seisakusho Ltd.). Japanese Patent 1968-18520. Aug. 8, 1968. Filed Oct. 8, 1964.

A method is proposed where the x-ray output distribution can be made uniform, thereby increasing the effective x-ray output. An auxiliary coil is installed within the betatron accelerating tube, to vibrate forcedly the electron orbit either in the radial or axial direction of the accelerating orbit. By exciting the coil, the orbit is disturbed to irradiate the target from various directions with the result of a uniform x-ray output distribution. (NSA of Japan)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 6333, 7049, 7356, and 7417.

7208 (EIR-139) DECAY RATE OF NEUTRON PULSES IN NON-1/v-POISONED D_2O. Doellgast, T. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Sept. 1968. 68p. (In German). Dep.

From the decay constant λ of the thermal neutron flux as a function of the concentration N of an additional non-1/v absorber, the thermalization parameter of a moderator can be obtained according to Friedman. The method is analogous to the diffusion cooling experiment in which λ was measured as a function of the geometric buckling B^2. If perturbation appears simultaneously in absorption and leakage, the thermalization effects are shown in the deviation of the $\lambda(N,B^2)$ surface from a plane. Since contradictory results are available for H_2O, the absorption perturbation experiment was carried out in D_2O as moderator with Sm and Cd as absorber. The spatial modes were isolated by the Meister method by Fourier analysis of the axial pattern of the flux. The use of B as pure 1/v absorber shows that no systematic errors occur. Instead of obtaining the thermalization parameters, the comparison with theory was undertaken directly on the λ surfaces, which were calculated for three different tested scattering models in the diffusion theory. The measurement values for all absorbers used fall in the range of λ surfaces included by the models. On the other hand, the measurement accuracy is not completely able to differentiate one of the three models. As supplementary products the Maxwell average absorption cross sections of Sm, Cd, and B were obtained. The accuracy of the method is limited experimentally by the size of the deviation of the λ surface from a plane (g-factor of the absorber) and on the theoretical side by the knowledge of the energy-dependent absorption cross section. An increase of the deviation from the plane by higher concentrations or temperatures will increase the accuracy only when better effective cross sections are available. (tr-auth)

7209 (GA-8782) TOTAL CROSS SECTIONS OF UC_2. Borgonovi, G.; Carriveau, G. W. (Gulf General Atomic, Inc., San Diego, Calif.). July 18, 1968. Contract AT(04-3)-167. 11p. Dep. CFSTI.

The neutron total cross section of depleted UC_2 was measured by the time-of-flight method in a transmission experiment. Inscattering and multiple scattering corrections were applied to the data. Since the scattering cross section is strongly dependent on the amount of ^{235}U in the sample, a comparison with the coherent elastic cross section was made to verify that the sample contained the assessed amount of ^{235}U. The scattering cross section was derived for energies below 1 eV. (D.C.W.)

7210 (RT/FI-(68)30) HETEROGENEOUS METHODS IN NEUTRON TRANSPORT THEORY. Boffi, V. C.; Molinari, V. G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 38p. Dep.

A new method for solving the Boltzmann integro-differential equation governing the monoenergetic neutron flux distributions in heterogeneous systems is presented. Three different cases of heterogeneity are discussed according to the nature of the kernel of the linear integral equation which defines the Fourier transform of the total flux. The result for the solution of the given integral equation is then inverted to give the original distributions as function of space and angle. (auth)

7211 EFFECT OF CHEMICAL BINDING ON THE NEUTRON SCATTERING CROSS SECTION OF HYDROGEN ATOMS AND DEUTERIUM ATOMS IN URANIUM HYDRIDE AND DEUTERIDE. Saad, Masoud A. (Atomic Energy Establishment, Cairo). Atomkernenergie, 13: 458-9(Nov.-Dec. 1968). (In German).

The neutron total cross sections for hydrogen and deuterium in UH and UD were measured over the neutron energy range from 0.05 to 0.5 eV using a crystal spectrometer. (D.C.W.)

7212 TOTAL NEUTRON-PROTON CROSS-SECTION IN NIOBIUM HYDRIDE AND DEUTERIDE. Brand, K. (Univ., Kiel). Atomkernenergie, 13: 458(Nov.-Dec. 1968). (In German).

The neutron total cross sections for hydrogen and deuterium in NbH and NbD were measured over the neutron energy range from 0.06 to 0.5 eV using a crystal spectrometer. (D.C.W.)

7213 APPLICATIONS OF THE DIRECTIONAL PHONON FREQUENCY FUNCTIONS IN NEUTRON SCATTERING INVESTIGATIONS OF HIGH POLYMERS. Lynch, John Edward Jr. Ann Arbor, Mich., Univ. of Michigan, 1968. 191p.

Thesis.

The incoherent and coherent differential neutron scattering cross sections for crystalline polymers are written in terms of the amplitude-weighted directional frequency functions. These functions describe the dependence of the cross sections on the vibrational frequencies and displacements of the scattering nuclei. The two-phonon G-functions are also defined and the orientation averages are performed, for both unoriented and stretch-oriented long-chain polycrystalline polymers. The orientation average of the Debye-Waller factor is performed separately from that of the remainder of the cross-section. The validity of this rather common approximation is evaluated. The vibrational frequencies and polarization vectors, which are required for the construction of the directional frequency functions, are obtained from the solutions of the dynamical matrix equations, which are written in terms of cartesian space group symmetry coordinates. To accomplish this, coordinate transformations are performed on published intramolecular and intermolecular internal coordinate force constant matrices. In addition, the normal polyethylene composite one- and two-phonon frequency functions, which are weighted by the Debye-Waller factors, are compared to published frequency spectra obtained from experimental cross sections for a stretch-oriented sample. The comparison of the calculated polyvinyl-chloride frequency functions with experimental values must however await the results of experiments which are now in progress. (Disser. Abstr.)

7214 TEMPERATURE DEPENDENCE OF SLOW NEUTRON INELASTIC SCATTERING BY IMPERFECT FERROMAGNETS. Dzyub, I. P. (Kiev Inst. of Theoretical Physics). Ukr. Fiz. Zh., 13: 1682-92(Oct. 1968). (In Russian).

A calculation is made of the differential cross section of slow-neutron inelastic scattering by imperfect ferromagnets with a small concentration of the impurity magnetic atoms. The technique developed makes it possible to take into account exactly the dynamics of the impurity atom surrounded by the crystal host atoms. The contribution of the quasi-localized and localized spin excitations to slow-neutron scattering is investigated. The temperature dependence of the one-magnon peak of coherently scattered neutrons is studied as well as the character of noncoherent neutron scattering. The numerical evaluations are given for solid solution of Mn in Fe. (auth)

7215 NEUTRON DIFFUSION PARAMETERS OF PERFLUORODIMETHYLCYCLOHEXANE USING A TWO-REGION PULSED-NEUTRON TECHNIQUE. Bisselle, C. A.; Wethington, John A. Jr. (Univ. of Florida, Gainesville). Nucl. Appl., 5: 445-55(Dec. 1968).

A technique was developed for determining the previously unknown thermal-neutron diffusion parameters, Σ_a and D, of a small amount of a moderating material, perfluorodimethylcyclohexane, C_8F_{16}. A two-region cylindrical system consisting of C_8F_{16} in the core region and water in the reflector region was pulsed with neutrons to obtain the decay constants for several heights of the system. By comparing these results with those obtained from a similar water-graphite experiment and by utilizing one-group two-region diffusion theory, it was possible to obtain the desired parameters for the fluorocarbon. This technique offers a convenient method for determining the neutron diffusion parameters of small samples of rare materials. (auth)

7216 QUANTUM CORRECTIONS TO THE NEUTRON TRANSPORT EQUATION. Diana, E.; Scotti, A. (EURATOM, Ispra, Italy). Phys. Rev., 177: 330-6(Jan. 5, 1969).

The singular behavior of the neutron transport equation, in the limit of zero neutron velocity, comes into play in an essential manner when one wants to study the nature of its asymptotic solutions. From the physical point of view, the consistency of such a study can be checked only if one knows explicitly the behavior of the quantum correction terms which are usually neglected. These terms are derived and explicitly exhibited using techniques of the statistical mechanics of irreversible processes. Neglecting terms of order greater than the second in the interaction potential between neutron and scattering centers and in the "short memory" approximation it is shown that the quantum correction terms can be expressed by means of Van Hove's scattering function $S(\vec{\kappa},\omega)$. Some models for the dynamics of the scattering centers (moderators) are discussed, and it is found that the correction terms are critically dependent on the detailed balance condition being satisfied. (auth)

Nuclear Properties and Reactions, A ≤ 5

Refer also to abstracts 7082, 7342, 7344, 7347, and 7355.

7217 NEUTRON SPECTRA FROM THE $^2H(p,n)2p$ REACTION AT 30 AND 50 MeV. Clough, A. S. (Queen Mary Coll., London); Batty, C. J.; Bonner, B. E.; Tschalaer, C.; Williams, L. E. Nucl. Phys., A121: 689-97(1968).

The energy spectrum of neutrons emitted from the $^2H(p,n)2p$ reaction was measured at angles from 0 to 40° for incident proton energies of 49.6 and 30.5 MeV. A peak is observed at the highest neutron energies due to the final-state interaction between the two remaining protons with low relative momentum. The results were analyzed using the impulse approximation together with the known value for the proton–proton scattering length, and good fits to the experimental data were obtained for angles forward of 10°. Improved fits to the data at wider angles are obtained when rescattering effects are included in the calculations. (auth)

7218 SINGLE RECHARGING OF π^+-MESONS AND SPECTROSCOPY OF LIGHT NUCLEI. Kopaleishvili, T. I. (Tbilissi State Univ., USSR). Phys. Lett., 28B: 163-4(Nov. 25, 1968).

It is shown, using nuclei with A = 4 as an example, that single recharging of π^+-mesons can be used to obtain spectroscopic information on light nuclei. (auth)

7219 PROTON–PROTON FINAL STATE INTERACTION IN THE $^3He(p,pd)p$ REACTION. Chang, C. C. (Univ. of Southern California, Los Angeles); Bar-Avraham, E.; Forster, H. H.; Kim, C. C.; Richardson, J. R.; Tomas, P.; Verba, J. W. Phys. Lett., 28B: 175-7(Nov. 25, 1968).

The final state p-p interaction was observed by means of a $^3He(p,pd)p$ angular correlation experiment. It was found that the probability of formation of the singlet state is most pronounced for an internal energy of the two-proton system of ≈0.4 MeV. (auth)

7220 Λ–Σ CONVERSION AND Λnp ISOSPIN-ZERO BOUND STATES. Toepfer, Alan J.; Schick, L. H. (Univ. of Southern California, Los Angeles). Phys. Rev., 175: 1253-6(Nov. 20, 1968).

The Faddeev equations with nonlocal separable Yamaguchi potentials were used to calculate the binding energy B_Λ of the Λ hyperon in the spin-doublet and spin-quartet Λnp isospin-zero systems. The calculations were performed with explicit consideration of Λ–Σ virtual conversion in neither, one, and both of the hyperon-nucleon (YN) spin channels. Relative to the case when it is neglected, Λ–Σ conversion changes the ΛN t matrix and introduces a ΛNN force. Results were obtained when only the change in the ΛN t matrix was considered, as well as when both this change and the ΛNN force were used. The effect of the change in the ΛN t matrix is always to reduce B_Λ. The effect of the ΛNN force depends upon the YN spin channel in which it is used as well as the total spin of the Λnp system. (auth)

7221 π^-–^4He INELASTIC AND CAPTURE REACTIONS LEADING TO EXCITED AND MULTINEUTRON FINAL STATES. Kaufman, Leon; Perez-Mendez, Victor; Sperinde, John (Univ. of California, Berkeley). Phys. Rev., 175: 1358-66(Nov. 20, 1968).

A beam of (140 ± 0.5)-MeV π^- particles was produced at the Berkeley 184-in. cyclotron and used to study the final-state interactions of three and four neutrons, and to look for excited levels of the α particle. Only one such level was found, with an excitation energy of 32 MeV and an intrinsic width smaller than the 1-MeV resolution. The data on the four-neutron final state, although not inconsistent with phase space, agree more closely with the assumption that there is a $^1S_0$ final-state interaction between two of the neutrons, the other two not interacting. Deuteron production was down by a factor of $\approx 10^3$ from proton production, and the proton spectrum indicates a stronger-than-expected interaction between the three neutrons in the final state. Lower limits for the production of a tri- or tetraneutron are set. (auth)

7222 COULOMB ENERGY OF ^3H AND ^3He. Folk, R. T. (Lehigh Univ., Bethlehem, Pa.). Phys. Lett., 28B: 159-60 (Nov. 25, 1968).

The Coulomb energy of ^3He and ^3H is large enough to account for the difference in the binding energies of these nuclei within the uncertainty caused by the impreciseness of the Coulomb energy operator. (auth)

7223 POLARIZATION OF THE NEUTRONS PRODUCED IN THE $D(d,n)^3He$ REACTION AT LOW DEUTERON BOMBARDING ENERGIES. Stoppenhagen, Walter Gene. Athens, Ohio, Ohio Univ., 1968. 129p.

Previous studies of the neutron polarization from the $D(d,n)^3He$ reaction show both surprising and conflicting results. The results of Hänsgen et al., show a marked resonance-like peaking in the neutron polarization at an average deuteron energy of 80 keV and having a width of 30 to 40 keV. In contrast, the results of Behof et al., indicate that the polarization is a slowly varying function of energy from 60 to 400 keV. Both sets of data differ considerably from the values predicted by Blin-Stoyle. Because of the important theoretical interest of Hänsgen's result and because of the practical value of this reaction as a source of polarized neutrons for users of low-energy accelerators, the neutron polarization was remeasured in the region from 80- to 120-keV incident energy. The polarization of the neutrons emitted at 50° in the laboratory system from a titanium deuteride target was measured. The polarization was inferred from measurements of the right-left asymmetry induced in elastic scattering from carbon at 50° in the laboratory system. The method of measurement utilized both an associated particle time-of-flight spectrometer, for neutron energy selection and for background reduction, and a spin-precession magnet to eliminate false asymmetries. The time-of-flight spectrometer employed the ^3He pulses from a surface-barrier solid-state detector as the start signal for a time-to-pulse-height converter. The stop signal was derived from the anode of a photomultiplier used as the neutron detector. Two time-of-flight systems were used to measure the right and left intensities at the same time. A time resolution of 5×10^{-9} sec (FWHM) was achieved under normal operating conditions. Corrections to the data were made for effects of target thickness and for multiple scattering effects. The analyzing power of the carbon scattering was calculated from the phase shifts of Willis et al., and averaged over the geometry of the carbon scatterer and the detectors. The results of the measurements show that the value of the polarization is between –11 and –15% and does not vary rapidly with energy. The values agree very well with the data of Behof et al., in the energy region common to both experiments. The agreement is particularly satisfying since the two experimental techniques were very different. No comparison is made to theoretical predictions since the dependence of the polarization on the neutron emission angle has not been measured. The results of the present study indicate that, for future applications using this reaction as a source of polarized neutrons, the incident energy can be chosen to maximize the neutron yield without reducing the magnitude of the polarization. (Diss. Abstr.)

7224 A STUDY OF THE THEORY OF THE REACTIONS $^3H(d,n)^4He$ AND $^3He(d,p)^4He$. Porter, William Samuel. New Haven, Yale Univ., 1958. 139p.
Thesis.

The reactions $^3H(d,n)^4He$ and $^3He(d,p)^4He$ were studied and the total cross sections were fitted using the one-level resonance formula of Breit and Wigner. The hypothesis of charge symmetry of nuclear forces was used as a guide in making the fits and the experimental data were to some extent used as a test of charge symmetry. Various forms of penetration parameters were tried in the channel widths and the fits subjected to the criterion of charge symmetry. The latter imposes a restriction on the inherent channel widths which enables certain fits to be ruled out. The possibility of obtaining fits at several radii in both the entrance and exit channels was investigated and it is established that several alternative radii are possible. Potential wells were used to compute some of the penetration parameters and were applied also to the elastic scattering of protons by ^4He, making use of results obtained by other investigators. The total cross sections for the reactions were also fitted using "one level plus background" formulas. These formulas are based on two formalisms, the Schematic Treatment of Breit and the R-matrix theory of Wigner and collaborators. These fits are also subject to the charge symmetry criterion and the form of the background is investigated. Several channel radii were tried and fits are found at each. The results using the R-matrix formalism are compared with those obtained by previous workers and with recent experimental data upon neutron scattering by ^4He. This comparison seems to be in favor of the present fits which employ a different boundary condition on the wave function in the interior region. (Diss. Abstr.)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 7208, 7343, 7346, and 7348.

7225 EFFECTS OF RESCATTERING ON THE REACTION $^6Li(\pi^-,2n)^4He$. Cheon, Il-tong (Kobe-Gakuin Univ., Kobe, Japan). Nucl. Phys., A121: 679-88(1968).

The rescattering effects on the reaction $^6Li(\pi^-,2n)^4He$ are investigated on the basis of previous theory by which absorption of pions at low energy by a deuteron is treated. The wave function of ^6Li is given by the α-deuteron cluster model including the nuclear correlations due to the short-range repulsive core of the nuclear force. The rescattering gives a large contribution to the total absorption rates and the momentum distributions of the emitted neutrons. In particular, the rescattering strongly interferes with the nuclear correlation of strength $\eta = 1.6$ fm^{-2}. The theoretical curves are in good agreement with the experimental data. (auth)

7226 RESIDUAL INTERACTION IN THE SHELL-MODEL WAVE FUNCTION OF ^6Li. Lodhi, M. A. K. (Texas Tech. Coll., Lubbock). Nucl. Phys., A121: 549-60(1968).

It is assumed that the basic shell-model idea of the two-body, nucleon–nucleon forces being completely represented by an averaged central potential, is, in particular, unlikely to be valid for ^6Li. Instead a substantial residual two-body interaction is expected which leads to admixture of configurations above $(1s)^4(1p)^2$ state in the harmonic oscillator well in order to give a correct wave function of ^6Li. This wave function is able to predict the type of residual interaction yielding the potential depth and range with the oscillator parameter. (auth)

7227 ENERGY AND ANGULAR DISTRIBUTION OF THE $^{14}N(n,\alpha)^{11}B$ REACTION INDUCED BY 14.1-MeV NEUTRONS. Bachinger, R.; Uhl, M. Oesterr. Akad. Wiss., Math.-Naturwiss. Kl. Sitzungsber., Abt. II, 176: 209-26(1968). (In German).

The reaction $^{14}N(n,\alpha)^{11}B$ was investigated at neutron energy of 14.1 MeV using nuclear emulsions. Natural nitrogen in gaseous form was used as a target with a target layer of 1.14 mg/cm^2. In the energy spectrum of the α particles, the levels of the ^{11}B residual nucleus were in agreement with other measurements. The 4.46- and 5.03-MeV groups were resolved only for the contribution of small angles. The angular spectra of the α particles which lead to the various levels of the residual nucleus suggest a strong contribution of the direct interaction mechanism; they show a preponderance of the forward direction, although the first excited level also shows a backward emission. A study by PWBA analysis of the simplest form essentially described the experimental curve. The adaptation of the theoretical curves by the selection of the parameters angular momentum L and radius R gives, at R ≅ 4.7 fm, agreement with the angular momentum selection rules. (tr-auth)

7228 ABSOLUTE VALUES OF (d,p) STRIPPING CROSS-SECTIONS. El-Nadi, M.; Sharaf, M. A. (Cairo Univ.). Phys. Lett., 28B: 165-7(Nov. 25, 1968).

A method suggested recently by Ford for the renormalized Born approximation is used for the calculation of the (d,p) stripping cross section. The results give reasonable values for the order of magnitude. (auth)

7229 HYPERFINE EFFECT IN THE MU-MESONIC ^{11}B ATOM AND INFORMATION ON ^{11}Be FROM MUON CAPTURE MEASUREMENTS. Deutsch, J. P.; Grenacs, L.; Lehmann, J.; Lipnik, P.; Macq, P. C. (Univ., Louvain, Belg.). Phys. Lett., 28B: 178-81(Nov. 25, 1968).

The partial rates in the capture of muons by ^{11}B were measured for the ground state and first excited level of ^{11}Be. The transition between the hyperfine states of the $\mu^- + {}^{11}B$ mesonic atom was observed indirectly. The 320 keV γ ray in ^{11}Be, which follows the capture of the muon in ^{11}B, was found to be broadened. Nuclear structure information was obtained on the ground state and first excited state of ^{11}Be. (auth)

7230 DELAYED NEUTRONS FROM ^{13}B. Chiba, R. (Tokyo Inst. of Tech.); Nakamura, N.; Ebisawa, K.; Ikeda, M.; Kawai, N.; Murata, T. Phys. Lett., 28B: 173-4(Nov. 25, 1968).

Delayed neutrons from ^{13}B were observed with a half-life of 16 ± 1 ms. The branching ratio of delayed neutron to total β^--decay was estimated as $(5.2 \pm 2.6) \times 10^{-3}$. (auth)

7231 ELECTROEXCITATION OF THE GIANT RESONANCE IN ^{12}C. Kelly, Francis J. (Naval Ordnance Lab., Silver Spring, Md.); Ueberall, H. Phys. Rev., 175: 1235-42(Nov. 20, 1968).

The cross section for electroexcitation of giant resonance states in ^{12}C was evaluated using the model due to Kamimura, Ikeda, and Arima (a particle-hole model with selected two-particle–two-hole components describing surface oscillations superimposed on the giant resonance). The model seems capable of providing much of the fine structure observed in the recent Saskatchewan electron scattering experiments. The T = 1, 1$^-$ isospin and 1$^-$ and 2$^-$ spin-isospin collective states again play a dominant role, as in the previous Brown-Gillet model (with whose predictions our results are compared), but surface-vibration satellites and other smaller states add some amount of fine structure. Widths were evaluated by the reduced-widths formalism. (auth)

7232 THE $^{13}C(^3He,\alpha)^{12}C$ REACTION AND THE STRUCTURE OF ^{16}O. Weller, Henry Richard. Durham, N. C., Duke Univ., 1968. 147p.

Thesis.

The angular distributions of the outgoing alpha particles from the $^{13}C(^3He,\alpha)^{12}C$ reaction were measured in 100-keV steps from 5.1 to 8.4 MeV for the ground and first two excited state alpha groups. Elastic angular distributions resulting from the scattering of ^3He by ^{13}C and ^{12}C were measured at ^3He energies of 6.0, 7.0, and 8.0 MeV. Excitation curves of the alpha particles, protons and ^3He ions resulting from the bombardment of ^{13}C with ^3He were measured at various angles. The analysis was begun by examining the applicability of the distorted-wave Born approximation using code JULIE. This also entailed using the Optical Model (Code HUNTER) to obtain the input parameters for JULIE for the incoming channel. In this case the effects of adding a resonance term to the optical amplitude as formulated and coded by Tamura were also investigated. Next some features of the data were observed which suggest a compound nucleus mechanism, namely, symmetry about 90° in the angular distributions and resonant-like structure in the yield curves. Using the formalism of Blatt and Biedenharn and other considerations, a probable spin assignment of $J^\pi = 3^-$ to a state in ^{16}O at 27.6 MeV was made. This result also indicates a compound-nucleus interpretation of j dependence for our data. The implications of the statistical compound-nucleus theory were considered in two ways. First an attempt was made to see how the ratios of total cross sections were predicted from approximate transmission coefficients. Next the data were examined to see how consistent the data were with Ericson's theory of fluctuations. Then utilizing the doorway state concept of intermediate structure it seems possible to reconcile the features of the data which are single level in essence with the apparent statistical behavior. However, the question of the doorway state mechanism remains. A general computational technique is needed and found in the eigenchannel formalism. Although the complete problem is not yet solved, an approximation within the eigenchannel calculation allows one to relate theory and experiments. (Disser. Abstr.)

7233 SHORT-RANGE DYNAMICAL CORRELATIONS IN ^6Li FROM ELECTRON ELASTIC SCATTERING. Ciofi Degli Atti, C. (Istituto Superiore di Sanita, Rome). Phys. Rev., 175: 1256-9 (Nov. 20, 1968).

The charge form factor of the ^6Li nucleus was calculated in Born approximation, introducing the ground-state density Jastrow-type correlations. Good agreement with the experimental data was obtained with different oscillator lengths for s and p nucleons. A diffraction minimum was predicted at a value of the momentum q ≈ 2.8 fm^{-1}. (auth)

7234 SEMIDIRECT T-FORBIDDEN REACTION $^{12}C(d,\alpha)^{10}B$. Jaenecke, J.; Yang, T. F.; Polichar, R. M.; Gray, W. S. (Univ. of Michigan, Ann Arbor). Phys. Rev., 175: 1301-8(Nov. 20, 1968).

The T-forbidden (d,α) reaction on ^{12}C leading to the 0^+, T = 1 state in ^{10}B was investigated at deuteron bombarding energies from 13 to 21 MeV. The shape of the angular distributions is practically energy-independent. The angular distributions are characteristic of a direct-reaction mechanism, in agreement with the results obtained by Meyer-Schützmeister, v. Ehrenstein, and Allas for deuteron energies from 11 to 13 MeV. The excitation function shows two pronounced resonances in the range from E_d = 13 to 15 MeV with peak cross sections of 120 and 90 μb/sr, respectively. The resonances correspond to states in the compound nucleus ^{14}N at $E_x = 21.15 \pm 0.15$ MeV with a width Γ of ≈1.4 MeV, and at $E_x = 22.70 \pm 0.10$ MeV with a width of ≈0.9 MeV. This is the region of the giant electric dipole resonance. From E_d = 15.5 to 21 MeV, the cross section is small and the excitation function is practically energy-independent. The cross section in the peak of the angular distribution is about 5 μb/sr. Thus the reaction exhibits a contradictory behavior, having both direct- and compound-nucleus features. The reaction mechanism is discussed in terms of a two-step process consisting of a T-violating step and a (d,α)-like reaction. For the T-violating step, virtual Coulomb excitation and the preferential spin-flip process suggested recently by Noble for deuteron-induced reactions were considered. A consideration of the characteristics and estimated magnitudes of the various effects suggests that the spin-flip process or (virtual) E1 Coulomb excitation of the deuteron (polarization of the deuteron in the Coulomb field of the other nucleus) can probably explain the experimental re-

sults for $E_d > 15.5$ MeV. However, it appears that these processes cannot account for the magnitude and the resonance-like behavior of the cross section of $E_d = 13$ to 15 MeV. A mechanism is suggested which postulates the existence of certain clusterlike, quasibound two-particle–two-hole states in the region of the giant resonance. The existence of such states has been suggested by Gillet, Melkanoff, and Raynal in a study of the fine structure of the giant resonance. The proposed reaction would proceed by an induced spin-slip in the deuteron at the corresponding bombarding energies. (auth)

7235 BETA DECAY OF ^{16}N TO THE 6.05-MeV STATE OF ^{16}O. Warburton, E. K.; Harris, W. R.; Alburger, D. E. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 175: 1275-82(Nov. 20, 1968).

The β-ray branching of ^{16}N to the 6.05-MeV 0^+ first excited state of ^{16}O was detected by observing the subsequent positron-electron nuclear pair emission from the 6.05-MeV level with a magnetic pair spectrometer. A previously developed spiral baffle system was used in the spectrometer to enhance the sensitivity for detecting the 6.05-MeV E0 pair line relative to the 6.13-MeV E3 pair line, the latter following the principal ^{16}N β-ray branch. The branch to the 6.05-MeV state was found to be $(1.2 \pm 0.4) \times 10^{-4}$ per decay. Based on the measured branching ratios, the log f_1t values for the unique first-forbidden decays to the ground and 6.05-MeV states are calculated to be 9.12 ± 0.04 and 9.98 ± 0.15, respectively. The results are consistent with recent descriptions of the ground and first excited states of ^{16}O. (auth)

7236 FAST-PHOTONEUTRON SPECTRA DUE TO 55 TO 85-MeV PHOTONS. Kaushal, N. N.; Winhold, E. J.; Yergin, P. F.; Medicus, H. A.; Augustson, R. H. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 175: 1330-6(Nov. 20, 1968).

Energy spectra of fast photoneutrons from eighteen elements (Li, Be, B, C, N, O, Al, S, Fe, Cu, Zn, In, Sn, Ta, Tl, Pb, Bi, and U) were measured at 67 1/2°, using thin-target bremsstrahlung from the Rensselaer linac. The neutron detection system utilized a 100-meter flight path and had an over-all time resolution of 0.4 nsec/m. Measurements of the spectra from each target at bremsstrahlung energies of both 55 and 85 MeV permitted extraction of neutron difference spectra effectively due to photons between 55 and 85 MeV. Absolute normalization of the spectra was effected by comparison with the experimentally measured photo-neutron spectrum of deuterium. Difference spectra were obtained for neutron energies greater than 10 MeV. Cross sections for production of these neutrons ranged from 59 μb/sr for lithium to 1.28 mb/sr for uranium. The experimental data were compared to the predictions of the quasideuteron model as recently modified by Levinger, with secondary-neutron effects estimated by Monte Carlo calculations. Good agreement was obtained for the absolute-neutron-production cross sections and the shapes of the neutron energy spectra over the range of targets studied. (auth)

7237 STUDY OF ^{3}He-INDUCED REACTIONS ON ^{12}C. Lamba, C. M.; Sarma, N.; Thampi, N. S. (Bhabha Atomic Research Centre, Bombay). Nucl. Phys., A122: 390-400(1968).

The differential cross sections for elastic scattering of ^{3}He by ^{12}C and for four proton groups from the reaction ^{12}C(^{3}He,p)^{14}N were measured over the energy range E(^{3}He) = 5.29 to 5.50 MeV in steps of 10 keV in the angular range 30 to 170°. The averaged elastic scattering angular distributions were analyzed in terms of optical and statistical models. Various optical potential sets were found and were compared with existing data. The compound-nucleus level overlap parameter Γ/D_0 and the spin cut-off parameter σ as obtained from elastic scattering and from statistical-model analysis of three proton groups were found to be consistent. (auth)

7238 ANALYSIS OF A STRIPPING REACTION TO A DOUBLET OF UNBOUND LEVELS. Huby, R.; Liu, Q. K. K. (Liverpool Univ.). Nucl. Phys., A122: 145-52(1968).

The angular distribution of protons as measured in a recent experiment resulting from the (d,n) reaction on ^{12}C leading initially to a doublet of unbound levels in ^{13}N, which subsequently undergo proton decay is analyzed. It is shown that, although an accurate theoretical calculation would be difficult, the Butler theory (in so far as its approximations are valid) in conjunction with R-matrix theory permits a very complete analysis, which in effect resolves the contributions from the two levels of the doublet that are not resolved in the experiment. The relative reduced widths of the two levels are deduced and found to agree well with values obtained from proton elastic scattering on ^{12}C. (auth)

7239 INVESTIGATION OF j-DEPENDENCE OF THE VECTOR ANALYZING POWER OF THE REACTION ^{6}Li(d,p_0) AND ^{6}Li(d,p_1) WITH PURE VECTOR-POLARIZED DEUTERONS OF ENERGY 2.1 TO 10.9 MeV. Duerr, W.; Clausnitzer, G.; Fick, D.; Fleischmann, R.; Hofmann, H. M.; Kilian, K. (Univ., Erlangen, Ger.). Nucl. Phys., A122: 153-64(1968).

In the case of the ^{6}Li(d,p)^{7}Li reaction, where no j-dependence had been seen in the polarized angular distributions of the protons, one can see pronounced differences in the angular distributions of the vector-analyzing power of the two possible $l_n = 1$ transitions to the ground state and first excited state of ^{7}Li. In order to extract j-values from the angular distributions of the vector-analyzing power, compound nucleus effects must be discussed. Only the transition to the first excited state of ^{7}Li seems to be free of compound nucleus effects at forward angles. Therefore, one can use in this case the angular distribution of the vector-analyzing power to get j-values. (auth)

7240 INVESTIGATION OF HIGH-ENERGY PHOTONEUTRONS FROM CARBON. Rawlins, J. A.; Glavina, C.; Ku, S. H.; Shin, Y. M. (Saskatchewan Accelerator Lab., Saskatoon, Canada). Nucl. Phys., A122: 128-44(1968).

The spectra of photoneutrons produced by 103-MeV bremsstrahlung bombardment of ^{12}C was measured at lab angles of 30, 60, 90, 112, and 142° using time-of-flight techniques. The angular distributions in the giant resonance region are compared with the predictions of 1p-1h theory. The angular distributions above the giant resonance region exhibit a forward anisotropy which increases with increasing neutron energy. The results are compared with single-particle and cluster theories. It is found that the angular distribution may be explained best using a quasi-alpha-particle theory. (auth)

7241 ENERGY LEVELS OF ^{19}F AND ^{19}Ne. Gul, K. (Oxford Univ.); Armitage, B. H.; Hooton, B. W. Nucl. Phys., A122: 81-96 (1968).

Information on the level structure of ^{19}F and ^{19}Ne was obtained from the ^{19}F(p,p′)^{19}F reaction with 9-MeV protons using a magnetic spectrograph and also from the measurement of angular distributions for the ^{18}O(d,n)^{19}F and the ^{17}O(^{3}He,n)^{19}Ne reactions. The last two reactions were studied at an incident energy of 3 MeV, and the energies of the outgoing neutron groups were measured with time-of-flight techniques. The angular distributions resulting from both the deuteron-induced and the ^{3}He induced reactions were compared with the results of DWBA one-particle and two-particle stripping theory, respectively, and new information on the position of energy levels and on spin and parity assignments is presented. (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 6295, 6305, 6306, 7236, 7281, and 7348.

7242 (AAEC/TM-466) A MEASUREMENT OF $\Gamma\gamma$ FOR THE 132-eV ^{59}Co RESONANCE. Wall, T. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). July 1968. 13p. Dep.

The radiative width for the 132-eV resonance in ^{59}Co was determined using an activation technique. The value of 0.48 ± 0.04 eV obtained leads to acceptable calculated values for the thermal cross section and resonance integral of ^{59}Co. The usefulness of ^{59}Co as a neutron flux detector in nonthermalized spectra is also discussed. (auth)

7243 (AE-337) NEUTRON ELASTIC SCATTERING CROSS SECTIONS OF IRON AND ZINC IN THE ENERGY REGION 2.5 TO 8.1 MeV. Holmqvist, B.; Johansson, S. G.; Kiss, A.; Lodin, G.; Wiedling, T. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Oct. 1968. 29p. Dep.

Angular distributions were measured for the elastic scattering of neutrons from iron at five energies between 3.0 and 8.1 MeV and from zinc at eight energies between 2.5 and 8.1 MeV. The time-of-flight technique was used. Corrections for neutron flux attenuation, multiple elastic scattering, and the finite geometry of the source-sample-detector system were made by using a Monte Carlo program. An optical model potential with Saxon-Woods form factors was used to fit theoretical angular distributions to the experimental distributions. The parameter values giving the best fits to the experimental distributions were calculated by a computer. (auth) (Sweden)

7244 (INP-613) ELASTIC SCATTERING OF ALPHA PARTICLES ON ^{39}K NUCLEI IN THE ENERGY RANGE FROM 22.1 MeV TO 28.2 MeV. Bobrowska, A.; Budzanowski, A.;

Grotowski, K.; Jarczyk, L.; Micek, S.; Niewodniczanski, H.; Strzalkowski, A.; Wrobel, Z. (Institute of Nuclear Physics, Krakow (Poland)). 1968. 35p. Dep.

Angular distributions for elastic scattering of alpha particles on ^{39}K nuclei were measured over the angular range from 20 to 179° (center of mass) at alpha particle energies 22.1, 23.1, 23.6, 24.0, 24.6, 25.5, 26.5, 27.4, and 28.2 MeV. A strong increase of the cross section with well-developed oscillatory character was observed at the backward scattering angles. The experimental data are fitted with the semiclassical diffraction model at forward angles and the glory scattering model at backward angles. A difference of about 1 fm in radius parameters for both models was found. (auth)

7245 (SAL-9) STUDY OF PHOTONEUTRONS FROM ^{27}Al, ^{28}Si, ^{31}P, AND ^{32}S. Ku, Sang Hae (Saskatchewan Univ., Saskatoon. Saskatchewan Accelerator Lab.). Dec. 1967. 127p. Thesis.

Photoneutron spectra and angular distributions from ^{27}Al, ^{28}Si, ^{31}P, and ^{32}S produced by $E_{\gamma max}$ = 103 MeV bremsstrahlung were measured. The spectra were obtained simultaneously at five angles using time-of-flight techniques. In the giant resonance region of the nuclei, the positions of resonance peaks are in good agreement with previous experiments, and the angular distributions are practically independent of the neutron energy. It is not possible to determine the multipolarities involved or to compare the data quantitatively with theory due to the complexity of the spectrum. Above the giant resonance region, the yields at 90° fall off nearly exponentially and the angular distributions show a forward peaking which becomes more pronounced with increasing neutron energy. The angular distribution and yield are compared with existing models. The single-particle and quasi-deuteron models were found unsatisfactory to fit the experimental angular distributions. The quasi-alpha particle model gives a reasonable agreement for the angular distributions but a much smaller cross section than is observed. (auth)

7246 MEASUREMENTS OF THE (α,t) REACTION. Matoba, Masaru; Kumabe, Isao (Kyoto Univ.). Genshikaku Kenkyu, 13: 335-51(Sept. 1968). (In Japanese).

The (α,t) reaction on medium-weight nuclei was measured at an incident alpha energy of 29 MeV using a system which consists of a small permanent magnet, a $\Delta E-E$ semiconductor detector assembly, an adder circuit system, and a two-dimensional pulse-height analyzer. This system satisfactorily identified tritons having energies from several MeV to about 20 MeV. (NSA of Japan)

7247 FORMATION AND DECAY OF THE COMPOUND NUCLEUS ^{68}Ge. Ruddy, Francis Henry. Burnaby, British Columbia, Simon Fraser Univ., 1968.

Thesis.

Experimental excitation functions were measured by radiochemical means for a number of reactions proceeding through the compound nucleus ^{68}Ge. The target-projectile pairs were: $^{4}He + ^{64}Zn$, $^{12}C + ^{56}Fe$, and $^{16}O + ^{52}Cr$ leading to the following reactions: (α,γ), (x,p), (x,n), (x,pn), and (x,2n). Recoil ranges were measured for products of the alpha-induced reactions in order to determine those reactions which proceeded by compound nucleus formation and decay. It was found that the "independence hypothesis" is verified for reactions induced by different target-projectile pairs but proceeding through compound nuclei of nearly equal angular momentum. Excitation functions were calculated with the SFU IBM System 360/40 computer via the statistical theory of nuclear reactions according to a formalism containing the explicit dependence of nuclear emission probabilities on angular momentum. Probabilities for γ-ray emission were calculated according to the single-particle model coupled with enhancement functions chosen to reflect experimentally observed collective effects. Agreement between experiment and calculations was found to be good for the $^{64}Zn + ^{4}He$ excitation functions. The "high energy tails" of the excitation functions were found to be accounted for by effects of γ-ray competition with particle emission when the latter was suppressed by angular momentum effects. Agreement in the $^{56}Fe + ^{12}C$ case was found to be very encouraging, considering the complexity of the target-projectile system and attendant theoretical difficulties. (Disser. Abstr.)

7248 MONOPOLE STATES IN ^{40}Ca. Damgaard, Joergen (Univ. of Copenhagen); Gortchakov, V. V.; Vagradov, G. M.; Molinari, A. Nucl. Phys., A121: 625-9(1968).

The $\tau = 1$ and $\tau = 0$ one-particle-one-hole monopole states in ^{40}Ca are calculated within the hydrodynamical model, with realistic forces, and within the framework of the Migdal theory. (auth)

7249 (n,n'γ) REACTIONS ON ^{79}Br, ^{89}Y, ^{176}Yb, AND ^{197}Au IN CONNECTION WITH THE QUESTION OF THE (n,2n) REACTION MECHANISM. Bornemisza-Pauspertl, P.; Hille, P. (Inst. fuer Atomkernforschung, Debrecen, Hungary). Oester. Akad. Wiss., Matte.-Naturwiss. Kl., Sitzungsber. Abt. II, 176: 227-43(1968). (In German).

The effective cross sections for the formation of the short-lived isomers of ^{79}Br, ^{89}Y, ^{176}Yb, and ^{197}Au were measured for a neutron energy of 14.7 ± 0.1 MeV to be 226 mb ± 13%, 524 mb ± 11%, 16.7 mb ± 21%, and 265 mb ± 10%, respectively. Half-life measurements on ^{79m}Br, ^{89m}Y, and ^{197m}Au gave 4.864 ± 0.034, 15.78 ± 0.11, and 7.94 ± 0.17 sec, respectively. The results were compared with values from the literature and were discussed in connection with questions on the (n,2n) reaction mechanism. It was shown that the (n,n'γ) reactions, especially on ^{79}Br and ^{89}Y, represent an essential fraction of the total nonelastic effective cross section. On the basis of the intermediate-nucleus model of nuclear reactions, calculations carried out for the isomer ratios of the (n,n'γ) reactions on ^{79}Br, ^{89}Y, and ^{176}Yb showed no contradiction with experimental results. (tr-auth)

7250 NEUTRON CAPTURE CROSS SECTIONS OF Cr, Mn, Ni, Nb, Ag, In, Sb, AND Au IN THE 8- TO 120-keV REGION. Spitz, L. M. (Univ. of Cape Town); Barnard, E.; Brooks, F. D. Nucl. Phys., A121: 655-72(1968).

Moxon-Rae detectors were used to measure ratios of the radiative capture cross section of elemental Cr, Mn, Ni, Nb, Ag, Sb and Au to that of In for neutrons of energy 8 to 120 keV. Relative capture cross sections of In for 8- to 30-keV neutrons were also measured. These were converted to absolute cross sections by using the In capture cross sections determined by Gibbons et al. The data were analyzed to determine p-wave strength functions for Nb, Ag, Sb and Au, and average radiation widths for Cr, Mn, and Ni. (auth)

7251 ENERGY LEVELS IN ^{72}Ge FROM THE DECAYS OF ^{72}Ga AND ^{72}As. Camp, David C. (Univ. of California, Livermore). Nucl. Phys., A121: 561-91(1968).

The γ-ray decay scheme and nuclear energy levels in ^{72}Ge were studied from the decays of ^{72}Ga and ^{72}As using a high-resolution 7 cm^3 Ge(Li) detector as the central detector in a Compton suppression spectrometer and using NaI(Tl)-Ge(Li) coincidence data. A discussion of all experimental variables encountered in reducing the Ge(Li) detector data is included. Careful hand and computer analyses determined as accurately as possible the energies and intensities of 122 separate γ-ray transitions; 85 of them observed in ^{72}Ga and 85 in ^{72}As. Of the total number of γ rays observed, 106 were placed in a proposed level scheme containing 32 levels. These include 20 new levels, six of which are tentative. The endpoint energies of the various β transitions, their branching ratios, and their log ft values were deduced from the γ-ray branching ratios. (auth)

7252 STUDY BY THE (n,t) REACTION ON ^{32}S AND ^{40}Ca WITH 14.7-MeV NEUTRONS. Sacher, R.; Warhanek, H. Oesterr. Akad. Wiss., Math.-Naturwiss. Kl., Sitzungsber. Abt. II, 176: 305-9(1968). (In German).

The cross sections of the (n,t) reactions on ^{32}S and ^{40}Ca were measured and were compared with previous results. Values of 6.7 and <7.5 b, respectively, were found. The possible errors and reasons for discrepancies with previous measurements are discussed. (J.S.R.)

7253 THE ROLE OF THE ISOSPIN IN (n,2n) NUCLEAR REACTIONS. Schlaeffer, W.; Hille, P. Oesterr. Akad. Wiss., Math.-Naturwiss. Kl., Sitzungsber. Abt. II, 176: 311-23(1968). (In German).

By measurement of the isomeric ratios of the reactions $^{35}Cl(n,2n)^{34g,m}Cl$ and $^{39}K(n,2n)^{38g,m}K$, a study was made to determine whether isospin plays a role in (n,2n) reactions. By comparison of the experimental values with calculations based on the law of conservation of angular momentum, it can be shown that the isospin can not be used for explanation of (n,2n) reactions. (tr-auth)

7254 MEASUREMENTS AND ANALYSES OF THE $d_{\frac{5}{2}}$ ANALOG RESONANCE IN THE $^{88}Sr(p,n)^{88}Y$ REACTION. Dutt, G. C.; Schrils, R. (Univ. of Kentucky, Lexington). Phys. Rev. 175: 1413-18(Nov. 20, 1968).

A study of the $d_{\frac{5}{2}}$ isobaric analog resonance in the $^{88}Sr(p,n)^{88}Y$ reaction is presented. Measurements of the cross section for the $^{88}Sr(p,n_0)^{88}Y$ and $^{88}Sr(p,n_1)^{88}Y$ reactions leaving the residual nucleus in the ground state and first excited state, respectively, were made. Analyses of the analog resonance (at laboratory proton energy of 5.066 MeV) were made using the coupled-channel formalism and the R-matrix approach of Robson. Good agreement with the experimental data was obtained using both theories for this particular resonance. (auth)

7255 COLLECTIVE EFFECTS IN THE $^{31}P(^{3}He,p)^{33}S$ REACTION. Cox, R. S. (Univ. of Kansas, Lawrence); West, R. W.; Ascuitto, R. J. Phys. Rev., 175: 1419-26(Nov. 20, 1968).

The two-nucleon transfer reaction was used to study collective effects in the ground and first three excited states of ^{33}S through the $^{31}P(^3He,p)^{33}S$ reaction at 6 MeV. The angular distribution of outgoing protons, measured in 5° intervals over the angular range from 0° to 75°, was analyzed in terms of the distorted-wave Born approximation and the strong-coupling collective model. Optical-model parameters were determined from measurements of the elastic scattering of ^3He by ^{31}P. It was found that the shape of the angular distribution of reaction protons leading to the ground state of ^{33}S is sensitive to the amount of d-wave admixture introduced into the $2s_{\frac{1}{2}}$ orbital by the deformation of the nucleus. It was found that the ground-state distribution could be reproduced with a deformation of −0.20, which compares well with the value of −0.17 determined from the quadrupole moment of ^{33}S. (auth)

7256 POSITRON DECAYS OF ^{36}Ca AND ^{32}K. Kavanagh, R. W. (Institut de Recherches Nucleaires, Strasbourg. California Inst. of Tech., Pasadena); Gallmann, A.; Aslanides, E.; Jundt, F.; Jacobs, E. Phys. Rev., 175: 1426-30(Nov. 20, 1968).

The positron decay of ^{36}Ca was investigated using the $^{36}Ar(^3He,n)$ reaction with an enriched ^{36}Ar gas target. A delayed 1568-keV γ ray with a half-life of 0.47 ± 0.02 sec is attributed to a positron branch to the 1695-keV level of ^{36}K. Upper limits of 3% or better were found for transitions to other low-lying levels. Using the measured half-life and the decay energies, the branching ratio to the 1695-keV level is calculated from β-decay systematics to be 21 ± 4%. The log ft for this transition (3.41 ± 0.09) establishes $J^\pi = 1^+$ for the 1695-keV level. An additional result was the observation of an allowed transition from ^{36}K to the 3936-keV level of ^{36}Ar. (auth)

7257 STUDY OF LEVELS IN ^{22}Ne, ^{26}Mg, AND ^{34}S BY PROTON PICKUP. Wildenthal, B. H.; Newman, E. (Oak Ridge National Lab., Tenn.). Phys. Rev., 175: 1431-41(Nov. 20, 1968).

Targets of Al and NaCl (^{35}Cl enrichment ≥99%) were bombarded with 34.5-MeV deuterons, and the spectra of emitted ^3He particles measured at eight angles in the forward octant. The angular distributions of the (d,^{3}He) reactions leading to the various residual levels were analyzed with the distorted-wave Born-approximation theory to determine the values of the transferred orbital angular momenta l_p and the corresponding values of the spectroscopic factors $C^2S(l)$. Most of the observed transitions proceed to states of known spin and parity; the analysis of the present data confirms these assignments and also yields several new parity assignments. The states in ^{22}Ne at excitation energies of 4.47 and 5.14 MeV were determined to be $(1, 2)^+$ and $(0, 1, 2, 3)^-$, respectively. States in ^{34}S at excitation energies of 3.30, 4.08, 4.69, 4.88, 6.17, 6.83, and 7.11 MeV were assigned even parity. The values of the spectroscopic factors extracted from the present data were compared with values predicted from shell-model calculations for A = 20 to 28 and A = 30 to 39 nuclei. The agreement between theory and experiment is such as to suggest that the abbreviated shell models under consideration offer an adequate explanation of the dominant characteristics of the low-lying states of these nuclei. (auth)

7258 STUDY OF THE $^{23}Na(^3He,d)^{24}Mg$ REACTION. Bearse, R. C.; Yntema, J. L. (Argonne National Lab., Ill.). Phys. Rev., 175: 1442-6(Nov. 20, 1968).

The $^{23}Na(^3He,d)^{24}Mg$ reaction induced by 35-MeV ^3He ions was studied for the first seven states in ^{24}Mg. Spectroscopic factors were extracted and were compared with theoretical predictions. The simple picture of the $K = 2^+$ band being built on the one-phonon γ-vibrational level appears to be contradicted by this evidence. A simple Nilsson argument predicts spectroscopic factors in fair agreement with the data. (auth)

7259 LIFETIME MEASUREMENTS FROM THE $^{39}K(p,\gamma)^{40}Ca$ REACTION. Dolan, K. W.; McDaniels, D. K. (Univ. of Oregon, Eugene). Phys. Rev., 175: 1446-52(Nov. 20, 1968).

Lifetime measurements with a Ge(Li) detector were made for several excited states of ^{40}Ca by the Doppler-shift attenuation method utilizing the $^{39}K(p,\gamma)^{40}Ca$ reaction. Agreement with results of $(p,p'\gamma)$ lifetime measurements is found for the levels at 3.904, 5.280, and 6.285 MeV. New lifetime results are reported for levels at 5.615 MeV, 7.465 MeV, and 7.562 MeV. An upper limit of 1% is set for the branching of the 3.904-MeV (2^+) to the 3.354-MeV (0^+) levels. Comparison is made with Gerace and Green's predictions that the 5.280-, 3.904-, and 3.354-MeV levels form a rotational band. Calibration of the resonance spectrum with ^{56}Co γ rays has resulted in precise establishment of level energies for ^{40}Ca, a better Q-value for the reaction of 8.3295 ± 0.0009 MeV, and the association of the lower member of the doublet near 5.615 MeV with the 4^- level in this region. New decay modes are established for the levels at 7.113, 7.562, and 7.811 MeV. (auth)

7260 LEVEL SCHEME AND CONFIGURATION MIXING IN ^{44}Sc. Schwartz, J. J. (Univ. of Rochester, N. Y.). Phys. Rev., 175: 1453-9(Nov. 20, 1968).

A spectroscopic study of ^{44}Sc up to an excitation energy of 5.5 MeV was made using the $^{43}Ca(^3He,d)^{44}Sc$ reaction. Observed angular distributions are compared with distorted-wave Born-approximation calculations, and spectroscopic strengths are extracted for transitions to pure as well as configuration-admixed states. Results are compared with theoretical calculations of the $(f_{\frac{7}{2}})^4$ spectrum. Most of the possible $f_{\frac{7}{2}}$ strength, but little of the possible 2p and $f_{\frac{5}{2}}$ strength, is observed. (auth)

7261 STATES IN ^{27}Al AND ^{89}Y USING HIGH-RESOLUTION SURFACE-BARRIER COUNTERS. Crawley, G. M.; Powell, D. L.; Rao, B. V. Narasimha (Australian National Univ., Canberra). Aust. J. Phys., 21: 803-10(Dec. 1968).

The resolution of a solid-state detector was investigated, and a best value of about 16 keV was obtained after cooling. The energy levels of ^{89}Y and ^{27}Al were measured with this detector. New states were observed at around 3.0 and 3.7 MeV in ^{89}Y, and over 20 new levels were noted in ^{27}Al. (auth)

7262 DETERMINATION OF THE LEVEL WIDTH AND DENSITY OF ^{32}S BETWEEN 17- AND 21-MeV EXCITATION ENERGY. Vonach, H. K. (Technische Hochschule, Munich. Argonne National Lab., Ill.); Katsanos, A. A.; Huizenga, J. R. Nucl. Phys., A122: 465-80(1968).

Excitation functions of the reactions $^{31}P(p,\alpha_0)$ and $^{31}P(p,\alpha_1)$ were measured with high resolution (<5 keV) at 7 angles in 10-keV steps for bombarding energies of 8.37 to 9.00 and 10.00 to 11.77 MeV. Autocorrelation functions were calculated from the excitation functions. From these autocorrelation functions, average widths of the compound states of ^{32}S were determined to be 38 ± 5, 47 ± 4, and 45 ± 5 keV for excitation energies of 18.1, 19.8, and 20.7 MeV, respectively. These widths are compared with statistical model calculations in which level densities of the Fermi-gas type are used. Good agreement between experiment and theory is obtained for level-density parameters which give a fair description of the known low-energy level densities of the nuclei which enter the calculations. (auth)

7263 LEVELS IN ^{56}Co STUDIED BY TWO-NUCLEON TRANSFER REACTIONS. Laget, J. M.; Gastebois, J. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Phys., A122: 431-64(1968).

The experimental results of the study of the $^{54}Fe(^3He,p)^{56}Co$ and $^{58}Ni(d,\alpha)^{56}Co$ reactions are presented. The DWBA analysis of the $^{54}Fe(^3He,p)^{56}Co$ reaction is discussed and leads to qualitative and quantitative accounts of the experimental data. The effects of a spin-isospin-dependent term in the stripping interaction and of a spin-orbit coupling term in the proton optical potential are investigated. The states for which the wave function is mainly of the $[\pi(f_{\frac{7}{2}})_0^2\pi p_{\frac{3}{2}},\nu p_{\frac{3}{2}}]_{\frac{1}{2}^-}$ configuration are identified in ^{56}Co. For this configuration, the energy splitting between analogue and non-analogue states is compared to the splitting in the neighbouring nuclei. (auth)

7264 GAMMA-RAY BRANCHINGS, ENERGIES, AND LIFETIMES OF ^{40}Ca LEVELS. Lindeman, H.; Engelbertink, G. A. P.; Ockeloen, M. W.; Pruys, H. S. (Rijksuniversiteit, Utrecht). Nucl. Phys., A122: 373-89(1968).

The γ decay of several $^{39}K(p,\gamma)^{40}Ca$ resonances in the range $E_p = 1.1$ to 2.5 MeV was investigated with a 30-cm^3 Ge(Li) detector. The branchings of nine resonances and 19 bound states in ^{40}Ca were determined. Precision γ-ray energy measurements yielded the energies of 19 bound states of ^{40}Ca with errors ranging between 0.3 and 2.0 keV. A determination of the Q-value of the $^{39}K(p,\gamma)^{40}Ca$ reaction gave the result Q = 8329.4 ± 0.9 keV. Mean lives (or limits) of 11 bound states in ^{40}Ca were found from measurements of γ-ray Doppler shifts. The results of the various measurements were compared with those given by other authors and with theoretical calculations. (auth)

7265 ISOMERIC CROSS-SECTION RATIOS FOR (n,2n) REACTIONS. Karolyi, J. (Inst. of Nuclear Research, Debrecen, Hungary); Csikai, J.; Petoe, G. Nucl. Phys., A122: 234-40(1968).

Isomeric cross-section ratios for (n,2n) reactions at 15 MeV were measured for the ^{34}Cl, ^{38}K, ^{69}Zn, ^{88}Y, ^{89}Zr, ^{91}Mo, ^{143}Sm, ^{203}Pb, and ^{207}Pb nuclei. On the basis of the Huizenga–Vandenbosch method, the isomeric ratios were calculated for the above nuclei and also for ^{44}Sc, ^{73}Se, ^{81}Se, ^{141}Nd, ^{164}Ho, and ^{198}Au. From the comparison of the calculated and measured isomeric ratios, the probable values of the spin cut-off parameters and the moments of inertia of the nuclei were deduced. (auth)

7266 keV NEUTRON CAPTURE IN NICKEL. Allen, B. J.; Kenny, M. J.; Sparks, R. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Nucl. Phys., A122: 220-33(1968).

A Ge(Li) spectrometer was used to observe gamma-ray transitions in three nickel isotopes after the capture of neutrons by natural nickel in the 10 to 95 keV energy range. Transitions to both $l_n = 1$ and $l_n = 3$ levels are observed, and the strengths of the high-energy transitions relative to thermal capture intensities are found to be substantially reduced. The energy dependence of the transition strengths in ^{59}Ni over a 3-MeV range is consistent with a statistical-model capture mechanism. The isotopic cross sections of nickel are estimated, and evidence is presented which discounts the presence of a dominant doorway state in the region of the binding energy of ^{63}Ni. (auth)

7267 ON THE PHOTODISINTEGRATION OF ^{51}V, Ni, ^{55}Mn, AND ^{59}Co. Garfagnini, R.; Piragino, G. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Nucl. Phys., A122: 49-58 (1968).

The energy distribution and polarization of photoneutrons from ^{51}V, natural nickel, ^{55}Mn and ^{59}Co were measured. The targets were irradiated with the γ-ray beam ($E_{\gamma max}$ = 85 MeV) of the Turin synchrotron, and the photoneutrons were detected with a diffusion cloud chamber filled with helium. The usual interpretation of the photoneutron spectra in terms of evaporation with a small contribution of direct reaction is not in agreement with the experimental results for neutron energies lower than 1.5 MeV. Qualitative discussion of other models is given to explain the experimental indication of photoneutron polarization found for ^{55}Mn and ^{59}Co. (auth)

7268 STUDY OF ^{24}Mg BY THE ^{23}Na(d,n) REACTION AT E_d = 6 MeV. Fuchs, H.; Grabisch, K.; Kraaz, P.; Roeschert, G. (Han-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Phys., A122: 59-72(1968).

Neutrons from the 6-MeV deuteron bombardment of ^{23}Na were investigated by the time-of-flight method. Angular distributions of (d,n) transitions to 32 states in ^{24}Mg up to 11.7 MeV excitation energy were obtained and analyzed with DWBA theory to yield l-values and spectroscopic factors. For the six lowest states, the results are compared to predictions of the unified model for axially symmetric and for tri-axial deformation. The strengths of transitions to proposed isobaric analogue levels of ^{24}Na states in ^{24}Mg are compared to corresponding ^{23}Na(d,p)^{24}Na data. The obtained agreement confirms the T = 1 assignment for these states. (auth)

7269 MECHANISM OF THE REACTION ^{24}Mg(d,p)^{25}Mg FROM 2 TO 4 MeV. Lee, S. M.; Hiratate, Y.; Miura, K.; Kato, S.; Morita, S. (Tohoku Univ., Sendai). Nucl. Phys., A122: 97-112 (1968).

Excitation curves and angular distributions for the reaction ^{24}Mg(d,p)^{25}Mg were measured over the range E_d = 2.02 to 4.22 MeV with solid-state detectors. The proton groups leading to the five lowest states of ^{25}Mg were measured. The results are analyzed by fluctuation theory and by the method of average angular distribution, i.e., the Hauser–Feshbach formula and DWBA theory. Ratios of the direct reaction to the compound-nuclear process obtained from the two methods are compared, and the validity of the fluctuation analysis in separating the reaction mechanisms is discussed. (auth)

7270 GAMMA-RAY SPECTRA FROM (d,pγ) REACTIONS IN ^{58,60}Ni AND ^{63,65}Cu. Naucler, L. (Univ. of Lund, Sweden); Bergqvist, L; Lundberg, B.; Nilsson, L. Nucl. Phys., A122: 113-27(1968).

High-energy transitions dominate the gamma-ray spectra from (d,pγ) reactions in Ni and Cu in agreement with results from (n,γ) experiments. The (d,pγ) measurements were performed on ^{58}Ni, ^{60}Ni, ^{63}Cu, and ^{65}Cu at an incident deuteron energy of 5.5 MeV. A NaI(Tl) spectrometer was used for detection of gamma rays and a silicon surface-barrier detector for protons. The pulses were analyzed in a two-parameter arrangement. Gamma-ray spectra from excitation energy regions ranging from about 2 MeV to the neutron binding energy were recorded simultaneously. The results can be explained in terms of single-particle transitions; the neutrons are captured into 3s and 2d levels above a few MeV strongly fed by the (d,p) reaction and make transitions to low-lying levels with 2p and 1f single-particle strengths. (auth)

7271 STRUCTURE IN THE GIANT RESONANCE OF ^{64}Zn AND ^{63}Cu. Owen, D. G.; Muirhead, E. G.; Spicer, B. M. (Univ. of Melbourne). Nucl. Phys., A122: 177-83(1968).

The photoneutron cross sections for ^{64}Zn and ^{63}Cu were measured with bremsstrahlung from threshold to 23 MeV. The ratio of the integrated cross sections was found to be 0.75 ± 0.08 giving for ^{64}Zn a value of 360 MeV · mb. Good agreement is found with the predictions of the dynamic collective model calculations of Huber for ^{64}Zn in the region of the giant resonance. Considerably more structure with appreciable strength is found experimentally in the region below 16 MeV. The ^{63}Cu cross section is considerably different from that of ^{64}Zn and compares favourably with the Huber prediction for ^{62}Ni provided the unperturbed dipole energy E_1 is lowered by 1.5 MeV. The excess structure observed in both cases below 16 MeV indicates a deficiency in the model in its present form and presumably calls for the incorporation of shell-model effects with collective correlations. (auth)

7272 STUDIES ON THE STRUCTURE OF ^{23}Ne. Nann, H.; Bass, R.; Groeneveld, K. O.; Saleh-Bass, Fatma (Johann Wolfgang Goethe-Univ., Frankfurt am Main). Z. Phys., 218: 190-212 (1969). (In German).

Low-lying states of ^{23}Ne up to about 3-MeV excitation energy were investigated by studying the reactions ^{22}Ne(d,p)^{23}Ne (E_d = 4 to 6 MeV) and ^{23}Na(n,pγ)^{23}Ne (E_n = 8 to 9 MeV). From the (d,p) data, l-values and spectroscopic factors for the transferred neutron were extracted by DWBA analyses. From the (n,pγ) data, γ-ray branchings and possible spin assignments were derived. The results are used to discuss the applicability of the Nilsson model and the excited core model to the nucleus ^{23}Ne. (auth)

7273 LEVELS EXCITED IN ^{73}Ge BY (d,p) AND (p,p') REACTIONS. Heymann, G. (South African Council for Scientific and Industrial Research, Pretoria); van der Merwe, P.; van Heerden, I. J.; Dormehl, I. C. Z. Phys., 218: 137-52(1969).

Angular distributions from the reactions ^{72}Ge(d,p)^{73}Ge and ^{73}Ge(p,p')^{73}Ge were studied with 8.0-MeV deuterons and 12.0-MeV protons, respectively, using the Aldermaston Tandem Van de Graaff generator and multi-angle magnetic spectrograph. The ground state Q-value of the (d,p) reaction was measured to be 4.571 ± 0.004 MeV. The energies, values of the transferred orbital angular momenta, parities, and transition strengths in both reactions were determined by use of distorted-wave Born-approximation calculations, for levels up to 3-MeV excitation energy. The sums of the transition strengths are compared with shell-model calculations as well as with values obtained in neighboring nuclei. Discrepancies between parity and possible spin assignments of states observed in the two reactions are discussed. (auth)

7274 γγ-TRIPLE CORRELATION MEASUREMENTS ON ^{56}Fe FOLLOWING (pp'γγ)-REACTIONS. Kreische, W.; Lampert, W.; Loos, G.; Weltle, D. (Univ., Erlangen, Ger.). Z. Phys., 218: 153-80(1969). (In German).

The investigations of γγ triple correlations following (pp') reactions were used to determine the spins of the second and third excited level in ^{56}Fe and the E2/M1 mixing ratio of the transition from the third to the first excited level. The population numbers of the substates are also determined. At E_p = 4.9 MeV, the correlation associated with the second level was measured. At E_p = 5.5 MeV, the correlations associated with the second and third level and the angular distributions of the photons were investigated. The spin series of 0^+, 2^+, 4^+, 2^+ and a mixing ratio of δ = 0.20 was obtained. The results of the angular distributions and the correlations are compared. They agree well with experimental results of other authors, obtained by various methods of measurement, and with theoretical predictions. (auth)

7275 ISOSPIN-FORBIDDEN COMPOUND-NUCLEAR RESONANCES IN ^{25}Al AND ^{29}P. Teitelman, Bernard. New Brunswick, N. J., Rutgers - The State Univ., 1968. 141p.
Thesis.

The analogs of the ground state and first-excited state of ^{25}Na and ^{29}Al were studied as compound resonances in ^{25}Al and ^{29}P, respectively, formed by scattering protons from ^{24}Mg and ^{28}Si targets. Positions of these resonances, observed in the elastic and inelastic channels, were in excellent agreement with their locations available from delayed-proton, (p,t) and (p,γ) experiments, and the uncertainties in the excitation energies were reduced to ±6 keV. Assuming charge independence for the specifically nuclear interactions, it was therefore possible to accurately calculate Coulomb energy differences between the members of these isospin quartets with mass numbers 25 and 29 and to predict the masses of ^{25}Si and ^{29}S using an Isobaric Multiplet Mass Formula. Since both the formation and decay of the T = 3/2 compound resonances in ^{25}Al and ^{29}P violate isospin conservation, their widths turn out to be less than the experimental beam energy resolution; a method was devised to extract the true widths of these states by folding the spreading effects into the theoretical scattering expression by computer, and matching the observed anomalies at various scattering angles. Reduced widths for these resonances are found to be at least an order of magnitude smaller than those of neighboring, isospin-allowed T = 1/2 resonances. An interpretation of the reduced widths of the isospin-forbidden resonances is offered in terms of isospin mixing introduced through the

Coulomb interaction. In the experiments a previously unexplored proton energy range from 5.600 to 6.220 MeV on ^{24}Mg, and from 7.000 to 7.430 MeV on ^{28}Si was covered in 5-keV steps, locating several new T = ½ resonances. Inelastic yields to the excited 2^+ and 0^+ states of these targets showed sizeable direct-reaction contributions, while the cross sections to the excited 4^+ states were appreciable only on resonance. Resonant energies and total widths were extracted and l-value assignments made for the T = ½ resonances. (Diss. Abstr.)

7276 THE DECAY OF ^{61}Cu AND ^{59}Cu: ENERGY LEVELS OF ^{61}Ni AND ^{59}Ni. Walker, Donald Arthur. Corvallis, Oreg., Oregon State Univ., 1968. 143p.
Thesis.

The decay of ^{61}Cu and ^{59}Cu produced by (d,n) reactions on natural nickel was investigated. Gamma-ray energies and relative intensities were measured with a high-resolution Ge(Li) spectrometer. The gamma–gamma coincidence spectrum of ^{61}Cu was studied with a Ge(Li)–NaI(Tl) system. From these data decay schemes of ^{61}Cu and ^{59}Cu were constructed. Inferred log ft values together with the results of previous studies were used to make spin and parity assignments for the levels of ^{61}Ni and ^{59}Ni. Some previously reported ambiguities in spin assignments have been removed. The results are compared with recent theoretical shell-model calculations. An efficiency curve is also given for a 2 cm² × 6 mm Ge(Li) detector as well as curves for escape peak yield. The half-life of ^{61}Cu was measured as 3.32 ± 0.01 hours. (Diss. Abstr.)

7277 STUDY OF PHOTONEUTRONS FROM ^{27}Al, ^{28}Si, ^{31}P, AND ^{32}S. Ku, Sang Hae. Saskatoon, Can., Univ. of Saskatchewan, 1968. 124p.
Thesis.

Photoneutron spectra and angular distributions from ^{27}Al, ^{28}Si, ^{31}P, and ^{32}S produced by $E_{\gamma max}$ = 103-MeV bremsstrahlung were measured. The spectra were obtained simultaneously at five angles using time-of-flight techniques. In the giant resonance region of the nuclei, the positions of resonance peaks are in good agreement with previous experiments, and the angular distributions are practically independent of the neutron energy. It was not possible to determine the multipolarities involved or to compare data quantitatively with theory due to the complexity of the spectrum. Above the giant resonance region, the yields at 90° fall off nearly exponentially, and the angular distributions show a forward peaking which becomes more pronounced with increasing neutron energy. The angular distributions and yields were compared with existing models. The single particle and quasi-deuteron models were found unsatisfactory to fit the experimental angular distributions. The quasi-alpha particle model gives a reasonable agreement for the angular distributions but a much smaller cross section than is observed. (Diss. Abstr.)

7278 NUCLEAR STRUCTURE OF ^{56}Mn. Comfort, Joseph Robert. New Haven, Yale Univ., 1968. 273p.
Thesis.

The ^{55}Mn(d,p)^{56}Mn reaction was studied with 10-keV resolution at a deuteron bombarding energy of 7.5 MeV using the MIT-ONR Van de Graaff accelerator and multigap magnetic spectrograph. Angular distributions were obtained for most states up to 5.5 MeV and for strong states up to about 6.5 MeV of excitation energy. A distorted-wave (DW) analysis was carried out in order to extract the orbital angular momentum transfer l_n and the transition strength $(2J_f + 1)S_{lj}$ for each state. Very careful consideration was given to the selection of optical-model parameters. The DW analysis revealed the presence of considerable configuration mixing in the ^{56}Mn spectrum. The l_n = 3 spectroscopic factors for the ground and first excited states are about twice as large as those for l_n = 1. Parities are assigned to states which exhibit clearly identifiable stripping patterns. A discussion of possible spin assignments is given, particularly for the states below 1 MeV of excitation energy. A comparison of the summed l_n = 1 and l_n = 3 transition strengths with the (d,p) sum-rules suggests that the DW calculations are possibly accurate to about 20% and that the ^{55}Mn ground state has a significant admixture of the neutron $1f_{\frac{5}{2}}$ orbital. A comparison of the transition strengths from the (d,p) and (n,γ) reactions indicates that the latter has a large direct mechanism component. Values of the total angular momentum transfer j_n are inferred for eight states. The statistical model is found to be consistent with the present data. Indications are given that the distribution of nearest-neighbor spacings retains some of the features of the Wigner distribution for levels of the same spin and parity. Shell model calculations are discussed. They are very difficult to perform for ^{56}Mn because of the large extent of configuration mixing. The mixing suggests a deformed model. Preliminary calculations of the Nilsson model with Coriolis coupling are presented and are found to give encouraging results. Some additional experiments are suggested. (Diss. Abstr.)

7279 AN ANGULAR-CORRELATION STUDY OF THE ^{24}Mg(^{3}He,αγ)^{23}Mg REACTION. Haun, Larry Carroll. Durham, N. C., Duke Univ., 1968. 205p.
Thesis.

Nine excited states of ^{23}Mg were investigated with the ^{24}Mg(^{3}He, αγ)^{23}Mg reaction at ^{3}He bombarding energies of 6.37 and 8.05 MeV using the angular-correlation method of axial symmetry. The observed α particles were detected in an annular semiconductor counter positioned at 180° relative to the beam direction. From the analysis of the experimental angular correlations, and in conjunction with known l_n values for ^{23}Mg, spin and parity assignments of $\frac{5}{2}^+$, $\frac{7}{2}^{(+)}$ $(\frac{3}{2})$, $\frac{1}{2}^+$, $\frac{3}{2}^{(+)}$ $(\frac{5}{2})$, $\frac{1}{2}^-$ $(\frac{3}{2}^-)$, $\frac{3}{2}^-$, $(\frac{5}{2}^+)$, and $\frac{1}{2}^+$ were established for the levels at 0.451, 2.048, 2.356, 2.712, 2.768, 3.792, 3.968, and 4.353 MeV, respectively. Gamma-ray branching ratios were determined for each of these levels as were the γ-ray multipole mixing ratios for most of the transitions. Coincidence measurements performed with a 20.6 cc Ge(Li) detector led to the determination of the decay modes of the 2.712- and 2.768-MeV levels. Yield curves of α particles detected in the annular counter and leading to the ^{23}Mg ground state and the levels at 0.451, 2.048, and 2.356 MeV were measured for ^{3}He bombarding energies between 6.0 and 8.2 MeV. The predictions of a strong-coupling collective model are compared with the experimental results. The ground state and the levels at 0.451, 2.048, and 2.712 MeV can be regarded as members of a $K^\pi = \frac{3}{2}^+$ rotational band based on Nilsson orbit 7 with the ground state being the band head. The observed mixing and branching ratios for the γ-ray transitions among these levels agree with the model calculations, assuming the levels to be unperturbed by band mixing. A prolate deformation of η ≈ 4 is indicated. The levels at 2.356, 2.904, and 3.968 MeV can be identified as members of a $K^\pi = \frac{1}{2}^+$ rotational band based on Nilsson orbit 9 with the 2.356-MeV level being the bandhead. Band mixing between this band and the $K^\pi = \frac{3}{2}^+$ band was attempted in order to calculate the mixing and branching ratios for the 2.356- and 2.904-MeV levels. The negative parity levels at 2.768 and 3.792 MeV are possible members of a $K^\pi = \frac{1}{2}^-$ rotational band based on Nilsson orbit 4 with the 2.768-MeV level, representing a core-excited state, being the bandhead. The observed level at 3.856 MeV appears to be the third member of this band with $J^\pi = \frac{5}{2}^-$. The level at 4.353 MeV can be interpreted as the bandhead of a $K^\pi = \frac{1}{2}^+$ rotational band formed by promotion of a core nucleon from Nilsson orbit 6 into orbit 7. (Diss. Abstr.)

7280 HIGH-ENERGY ELECTRON SCATTERING BY ^{23}Na. Savitskii, G. A.; Afanas'ev, N. G.; Gul'karov, I. S.; Kovalev, V. D.; Andreeva, I. V.; Khvastunov, V. M.; Shevchenko, N. G. (Kharkov Inst. of Physics and Tech.). Ukr. Fiz. Zh., 13: 1648–53(Oct. 1968). (In Russian).

Absolute cross sections of elastic and inelastic electron scattering by ^{23}Na were measured at the initial energy 225 MeV in the range of scattering angles 20 to 125°. The analysis of elastic scattering data in the modified Born approximation with the application of three models for the charge distribution (uniform-uniform, Gaussian-uniform, and shell models) allowed one to establish that it is the shell model with the parameter a_0 = 1.79 Fm that provides the best description of the experimental data. The fact enabled the half density radius c = 2.92 Fm, the surface thickness t = 2.28 Fm, the root mean square radius $\langle r^2\rangle^{\frac{1}{2}}$ = 2.96 Fm and the root mean quadruple radius $\langle r^4\rangle^{\frac{1}{4}}$ = 3.25 Fm to be determined. The analysis of the inelastic scattering with the excitation of the 2.08-MeV level which was made in the modified Born approximation by the model-dependent method gave the transition multipolarity λ = 2 and the reduced transition probability B(E2↑) = (107 ± 23) e^2Fm^4. The analysis by the model-independent method leads to B(E2↑) = (80 ± 11) e^2Fm^4 and to the transition radius R_{trans} = (3.93 ± 0.57) Fm. The preliminary analysis of the excitation with the energy 6.8 ± 0.4 MeV shows that two multipolarities E2 and E4 contribute to the transition. It is likely that the excitation of the experimentally unresolved levels at 6.27 and 7.10 MeV occurs. (auth)

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Refer also to abstracts 6304, 6306, 6878, 7208, 7236, 7246, 7249, 7250, 7265, and 7334.

7281 (ORNL–4280) NEUTRON PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MAY 31,

1968. (Oak Ridge National Lab., Tenn.). Oct. 1968. Contract W-7405-eng-26. 194p. Dep. CFSTI.

Progress in the nuclear and reactor physics research programs and the reactor and weapons shielding research programs is summarized, together with the activities of the Radiation Shielding Information Center. Developments in radiation detection and data-handling techniques are also outlined, as are theoretical studies for medium- and high-energy radiation shielding and experimental studies for medium-energy radiation shielding. (D.C.W.)

7282 (UJV-2081-F) DIPOLE STATES IN DEFORMED NUCLEI. Feifrlik, V.; Rizek, J.; Vogel, P. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Sept. 1968. 21p. Dep.

Energies and other characteristics of the dipole states with $K^\pi = 1^-$ and 0^- of the even-even deformed nuclei in the rare-earth region were investigated. The calculations were performed by using the method of finite Fermi system theory. It was shown, that with reasonable values of the interaction constants good agreement with the experimental value of the energy and energy splitting of the giant resonance can be achieved. The integrated γ absorption cross section is close to the theoretical value given by the sum rules. The influence of the superfluid pairing correlations is small as well as that of the interaction in the particle-particle channel. (auth)

7283 RANGES OF SOME FISSION PRODUCTS FORMED IN THE REACTION $^{239}Pu(n_{th},f)$. Ishimori, T.; Muenzel, H.; Pfennig, G. (Kernforschungszentrum, Karlsruhe, Ger.). Radiochim. Acta, 9: 187-94(Oct. 1968). (In German).

The mean range of some fission products produced in the reaction $^{239}Pu(n_{th},f)$ was determined by the thick target-thick catcher technique using a ^{239}Pu–Al alloy as target material. The kinetic energies of the fission products were calculated using a range-energy-relation proposed recently. A test of this relation with already published data yielded good agreement. For further evaluation, the average total kinetic energies and the average distances of the fragments at the saddle point shape according to the "two-ball-model" were calculated. A comparison with the corresponding values for the reactions $^{233}U(n_{th},f)$ and $^{235}U(n_{th},f)$ indicates that the mechanism of the fission process is very similar for the three reactions. Furthermore, the characteristic saddle-point shapes for symmetric and asymmetric fission are different. The influence of the formation of fragments with magic nucleon numbers on the saddle-point shape is evident. (auth)

7284 $^{199}Hg(n,ce)^{200}Hg$ STUDIES. Schult, O. W. B.; Kaiser, W.; Mampe, W.; Egidy, T. v. (Technische Hochschule, Munich). Z. Phys., 218: 95-108(1969).

The conversion-electron spectrum from slow neutron capture in ^{199}Hg was measured with the beta spectrometer at the reactor FRM. Approximately 100 conversion-electron lines with energies between 200 and 2300 keV were observed. The multipolarities and mixing ratios of about 50 transitions were determined. Branching and mixing ratios are compared with theoretical predictions. (auth)

7285 THE BETA BRANCHING RATIO AND CONVERSION COEFFICIENTS IN THE ^{137}Cs DECAY. Hansen, H. H.; Lowenthal, G.; Spernol, A.; van der Eijk, W.; Vaninbroukx, R. (EURATOM, Geel, Belgium). Z. Phys., 218: 25-36(1969).

The decay of ^{137}Cs has been reinvestigated using several precision counting methods. The emission rate of β-particles plus internal conversion electrons was measured by the 4π-proportional counter method using vacuum evaporated sources free of self-absorption and checked by the liquid scintillation method. The K-conversion coefficient was determined by the electron x-ray coincidence method using a magnetic spectrometer and a high resolution Si(Li) detector. The K/(L + M + ...) conversion ratio and a second less accurate value for the β-branching ratio were obtained from the recorded electron spectra. The γ-ray emission rate of all sources was determined to within ±0.14%, on the average, with a calibrated NaI(Tl) crystal detector. As a result, the intensity of the β-decay to the ground state of ^{137}Ba could be determined to 5.4 ± 0.3% of the ^{137}Cs decays, the K-conversion coefficient to 0.0916 ± 0.0004, and the K/(L + M + ...) conversion ratio to 4.41 ± 0.04. From these values, the γ-ray emission intensity is 85.1 ± 0.4% of the ^{137}Cs decays and the K x-ray emission intensity is 8.13 ± 0.10% of the emitted γ-rays. All errors are discussed in detail. (auth)

7286 NEUTRON CAPTURE IN ^{238}U. Price, D. L.; Chrien, R. E.; Wasson, O. A.; Bhat, M. R.; Beer, M.; Lone, M. A.; Graves, R. (Brookhaven National Lab., Upton, N. Y.). Nucl. Phys., A121: 630-54(1968).

The γ-ray spectrum following slow neutron capture in ^{238}U was measured as a function of incident neutron energy at the Brookhaven HFBR fast neutron chopper. The decay scheme proposed by previous (d,p) and high resolution thermal (n,γ) measurements was substantially verified. Partial radiation widths for s-wave resonances up to 117 eV were deduced. By using a simple multilevel analysis, the spectra between resonances from 21 eV down to thermal were fitted. The behavior of the strong transitions to low-lying l = 1 states is explained using a direct capture model, while the transitions to low-lying collective states can be explained by level-level interference. The distribution of El transition strengths is not consistent with a χ^2 distribution of one degree of freedom. (auth)

7287 NUCLEAR SPECTROSCOPY IN THE NEUTRON-DEFICIENT $173 \leq A \leq 185$ REGION. Harmatz, B.; Handley, T. H. (Oak Ridge National Lab., Tenn.). Nucl. Phys., A121: 481-528(1968).

The internal conversion spectra of deformed nuclei in the mass interval $173 \leq A \leq 185$ were investigated with permanent magnet spectrographs. By combining the conversion results with complementary data from independent photon studies, partial decay schemes are deduced from energy sums, multipolarities, and intensities of the transitions. The quantum numbers of nuclear energy levels are associated with intrinsic and collective modes of excitation in the framework of the Nilsson and Bohr–Mottelson models. Parameters relevant to rotational configurations and branching ratios of the de-exciting transitions are evaluated. The energy systematics of proton and neutron particle states in odd-mass nuclei are correlated with the particle-coupled spectra in adjacent doubly odd nuclei. More complete conversion electron measurements permit extension of nuclear level structures of $^{148,146}Sm$. (auth)

7288 NOTE ON THE β-CIRCULARLY POLARIZED γ ANGULAR CORRELATIONS IN THE DECAYS OF ^{46}Sc AND ^{58}Co. Meulenberg, A. (Vandebilt Univ., Nashville); Ramayya, A. V.; Hamilton, J. H.; Van Nooijen, B.; Pinajian, J. J. Nucl. Phys., A121: 529-34(1968).

The $\beta-\gamma$ circular polarization correlations of the (357 keV, $4^+ \rightarrow 4^+$, β^-) – (1.121 + 0.889 MeV, γ) cascade in ^{46}Sc and the (475 keV, $2^+ \rightarrow 2^+$, β^+) – (0.810 MeV, γ) in ^{58}Co were measured by using the standard forward scattering technique for the detection of circular polarization of γ-rays. The energy selection of the β rays was performed with a magnetic lens spectrometer. The measured asymmetry coefficients, Fermi to Gamow–Teller matrix element ratios, values of the Fermi matrix elements, isospin impurity coefficients and the effective Coulomb matrix elements were determined. (auth)

7289 MEASUREMENT OF (n,2n) EFFECTIVE CROSS SECTIONS AND INVESTIGATION OF SPIN DISTRIBUTIONS ON BOTH INDIUM ISOTOPES. Roetzer, H. Oesterr. Akad. Wiss., Math.-Naturwiss. Kl., Sitzungsber. Abt. II, 176: 289-304(1968). (In German).

The effective cross section of the (n,2n) reaction was measured on both In isotopes for the formation of isomers and the ground state of the final nucleus. Some data on the decay scheme of the reaction products were also obtained. The half-lives of the isomeric and ground states of ^{112}In were determined to be $\tau_m = 20.4 \pm 0.4$ min and $\tau_g = 14.5 \pm 0.58$ min. The effective cross section for the formation of the ^{115}In isomer by the (n,n') reaction was determined to be $\sigma_m = 83.5 \pm 4.2$ mb. The isomeric ratios obtained for $^{115}In(n,2n)$: $\sigma_m/\sigma_g = 4.28 \pm 0.92$ and for $^{113}In(n,2n)$: $\sigma_m/\sigma_g = 5.03 \pm 0.3$ were compared with the values calculated by the Vandenbosch–Huizenga formalism, by which the spin distribution parameter σ can be determined in both cases as $\sigma\ ^{115}(n,2n) = 3.5 \pm 0.4$ and $\sigma\ ^{113}(n,2n) = 2.8 \pm 0.1$. A comparison of the total (n,2n) effective cross sections with the values calculated by the Weisskopf formula shows good agreement. (J.S.R.)

7290 PRECESSION MEASUREMENTS FOLLOWING COULOMB EXCITATION WITH OXYGEN IONS. VI. HYPERFINE INTERACTIONS OF NUCLEI IN HIGHLY IONIZED ATOMS. Ben-Zvi, I.; Gilad, P.; Goldberg, M.; Goldring, G.; Schwarzschild, A.; Sprinzak, A.; Vager, Z. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., A121: 592-611(1968).

Measurements are reported of angular distributions of gamma rays from excited 2^+ states of various nuclei recoiling into vacuum or gas. The angular distributions are found to be perturbed by strong hyperfine fields generated by the highly ionized atoms. Both in vacuum and in gas, the interaction is found to be predominantly magnetic dipole and of a rapidly fluctuating character. In gas, the fluctuations in the field direction are due to collisions (at the rate of about 2×10^{13} sec^{-1} at atmospheric pressure), and in vacuum they are brought about by optical transitions (at a rate of about 3×10^{11} sec^{-1}). The average hyperfine field of Nd or Sm emerging from a solid target with 10-MeV kinetic energy is found to be 25.5 ± 2.5 MG. Measurements of g-factors of 2^+ excited states

were carried out, and the values of g-factors (relative to g(^{152}Sm)) are reported for ^{150}Sm, ^{154}Sm, ^{148}Nd and ^{150}Nd. (auth)

7291 A STUDY OF SOME OF THE GAMMA-RAY TRANSITIONS IN THE DECAY OF ^{194}Ir TO ^{194}Pt. Butt, D. K.; Lincoln, T. J. (London Univ.). Nucl. Phys., A121: 673-8(1968).

The gamma-ray spectrum of ^{194}Ir was examined up to 1.4 MeV with a Ge(Li) diode, and the relative intensities of the components were measured. Eight new gamma rays were observed. Modifications to the decay scheme of ^{194}Pt are suggested. (auth)

7292 NUCLEAR STRUCTURE IN $^{133\ 135}$Xe AND $^{133\ 135}$Cs. Alexander, Peter; Lau, John P. (Isotopes-A Teledyne Co., Westwood, N. J.). Contract DA-49-146-XZ-517. Nucl. Phys., A121: 612-24(1968).

The relative gamma-ray intensities of transitions depopulating the ^{133,135}Xe ground and isomeric states as well as the ^{133}Ba ground state were measured using a semiconductor detector. The half-lives of these xenon states were measured and were found to differ slightly from the reported values. The K internal conversion coefficient of the ^{135}Xe isomeric transition was determined to have the value $\alpha_K = 7.68 \pm 0.25$. The ^{130}Te(α,n)^{133,133m}Xe cross sections were measured in a stacked-foil experiment. More than nine new transitions were observed from unreported levels in ^{135}Cs. New levels are proposed at 408.2, 981.7 and 1062.6 keV. The above results are discussed in terms of the level schemes. (auth)

7293 SPIN AND MAGNETIC MOMENT OF THE 72.5 keV STATE OF ^{145}Nd. Kaindl, G. (Technische Hochschule, Munich). Phys. Lett., 28B: 171-2(Nov. 25, 1968).

From Moessbauer measurements the spin and the magnetic moment of the 72.5-keV level of ^{145}Nd were determined: $I_e = 9/2$ and $\mu(9/2) = -1.121 \pm 0.013$ nm. The multipolarity of the transition was found to be M1 with a possible E2 admixture of $\delta^2 < 0.04$. (auth)

7294 HIGH-ENERGY INTERNAL-CONVERSION COEFFICIENTS. Church, E. K. (Pitman-Dunn Research Labs., Philadelphia. Brookhaven National Lab., Upton, N. Y.). Phys. Lett., 28B: 168-70(Nov. 25, 1968).

The properties of high-energy internal-conversion coefficients are explored above the range of existing tabulations using the standard conversion formalism with approximate corrections for the effects of the finite nuclear size and atomic screening. Results are illustrated by the case of ^{200}Hg. (auth)

7295 ISOBARIC ANALOGUE RESONANCE AS A COLLECTIVE EFFECT OF STRONG COUPLING OF CHANNELS. Balashov, V. V.; Grishanova, S. I. (Moscow State Univ.). Phys. Lett., 28B: 157-8(Nov. 25, 1968).

The proton decay widths of the 0^+ state in ^{208}Bi (the analogue of the ground state of ^{208}Pb) are calculated using the method of close coupling of channels. (auth)

7296 DECAY OF ^{141}Sm, ^{142}Sm, AND ^{143}Sm. Bleyl, H.-J.; Muenzel, H.; Pfennig, G. (Kernforschungszentrum, Karlsruhe, Ger.). Radiochim. Acta, 9: 173-6(Oct. 1968). (In German).

The ^{141}Sm, ^{142}Sm, and ^{143}Sm isotopes were produced by (α,xn) reactions on ^{142}Nd. After the bombardment the Sm fraction was isolated by means of ion exchange columns and the decay as well as the γ spectra of the samples were determined. A numerical analysis of the decay data yielded the following half-lives: ^{141m}Sm, 22.9 ± 0.5 minutes, ^{142}Sm 72.4 ± 0.1 minutes, and ^{143}Sm 8.83 ± 0.01 minutes. No indication of a 20-day ^{141}Sm-activity was found. A decay scheme for ^{143}Sm/^{143}Pm is proposed. (auth)

7297 DECAY CHARACTERISTICS OF THE GADOLINIUM ISOTOPES ^{145}Gd AND ^{144}Gd. Keller, K. A.; Muenzel, H. (Kernforschungszentrum, Karlsruhe, Ger.). Radiochim. Acta, 9: 176-80(Oct. 1968). (In German).

Gadolinium-145 and the so far unknown ^{144}Gd were produced by (α,xn) reactions on enriched ^{144}Sm. The separation of the activities was made by means of ion exchange columns or a mass separator. The evaluation of β-decay curves and γ spectra yielded the half-lives of the Gd isotopes as well as the energy and relative intensity of the γ rays. Preliminary decay schemes for ^{144}Gd and ^{145}Gd are proposed. The results show that the half-life of ^{143}Gd is likely to be smaller than 1 min. (auth)

7298 THE GAMMA-RAY SPECTRUM OF ^{93}Y. Polak, P. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Radiochim. Acta, 9: 225-6(Oct. 1968).

Gamma rays with a half-life of 102 hr were observed in a series of measurements on fairly short-lived fission products and were attributed to the decay of ^{93}Y. The energies and intensities of the gamma lines were determined, and revisions of the level scheme of ^{93}Zr were proposed. (D.C.W.)

7299 g-FACTOR MEASUREMENT OF A THREE-PARTICLE ISOMERIC STATE OF ^{209}Po FOLLOWING PULSED GENERATION IN (α,xn) REACTIONS. Yamazaki, T.; Matthias, E. (Univ. of California, Berkeley). Phys. Rev., 175: 1476-81(Nov. 20, 1968).

A 100-nsec isomer was found in ^{209}Po. The time-differential angular distribution of delayed γ rays was studied in the pulsed generation of aligned isomeric states in (α,xn) reactions with the use of cyclotron beam bursts. With a metallic lead target, no perturbation of the angular distribution during approximately 1 half-life could be detected. The g factor of the isomeric state was determined to be $g = +0.88 \pm 0.05$, which suggests an interpretation of this isomer as the $17/2^-$ three-particle states of the $[(h_{9/2}(p))^2 p_{1/2}(n)]$ configuration. (auth)

7300 ISOBARIC-ANALOG STUDY OF ^{90}Zr. Lieb, K. P.; Kent, James J.; Moore, C. Fred (Univ. of Texas, Austin). Phys. Rev., 175: 1482-93(Nov. 20, 1968).

Proton-induced analog resonance reactions were studied using the target ^{90}Zr. Excitation functions were measured for elastic and inelastic protons at angles of 70, 110, 130, 150, and 170°. The inelastic groups detected result from the 0^+ (1.75-MeV), 2^+ (2.18-MeV), 5^- (2.32-MeV), and the unresolved 4^- and 3^- (2.75-MeV) states in ^{90}Zr. In addition, proton inelastic angular distributions were taken on and off the more prominent resonances. In order to separate the resonances attributed to the 4^- and 3^- (2.75-MeV) proton group, excitation of the 4^- to 5^- and 3^- to 2^- γ rays were measured in a 26-cm^3 Ge(Li) detector. (auth)

7301 LEVELS IN ^{208}Pb POPULATED IN THE DECAY OF ^{208}Tl(ThC''). Pakkanen, A.; Kantele, J.; Suominen, P. (Univ. of Jyvaeskyla, Finland. Univ. of Helsinki). Z. Phys., 218: 273-81(1969).

Gamma rays in the disintegration of ^{208}Tl(ThC'') were studied with Ge(Li)Na I(Tl) anti-Compton and coincidence spectrometers. Several new transitions are reported, most of which are placed in a decay scheme incorporating excited states in ^{208}Pb at 2614.5; 3197.6; 3475.0; 3708.3; 3919.8; 3960.9; 3998.5; 4125.3; 4180.4; 4296.1; and 4480.0 keV. According to the present data, the recently reported intensity of 4.5 ± 1.5% of beta groups feeding levels near 4.3 MeV is far too large. (auth)

7302 MAGNETIC MOMENT AND CHANGE OF THE MEAN SQUARE CHARGE RADIUM OF THE 83.4-keV ROTATIONAL STATE IN ^{153}Eu. Richter, M.; Henning, W.; Kienle, P. (Technische Hochschule, Munich). Z. Phys., 218: 223-6(1969).

From Moessbauer effect measurements, the magnetic moment $\mu = +1.80 \pm 0.08$ nm of the 83.4-keV rotational state of ^{153}Eu and the ratio of the changes of the mean square charge radii $\Delta\langle r^2\rangle$ (^{153}Eu, 83 keV)/$\Delta\langle r^2\rangle$ (^{153}Eu, 103 keV) = +0.025 ± 0.008 were determined. The results are interpreted on the basis of mixing of rotational bands by the Coriolis force. (auth)

7303 ^{136}Xe(d,p) AND ^{136}Xe(d,t) REACTIONS. Moore, P. A. (Univ. of Texas, Austin); Riley, P. J.; Jones, C. M.; Mancusi, M. D.; Foster, J. L. Jr. Phys. Rev., 175: 1516-22(Nov. 20, 1968).

States of ^{137}Xe and ^{135}Xe were investigated via the ^{136}Xe(d,p) and ^{136}Xe(d,t) reactions with 13-MeV incident deuterons and an over-all energy resolution of 45 keV. Q-values of 1.637 ± 0.020 and −1.723 ± 0.020 MeV were obtained for the respective ground state ^{136}Xe(d,p)^{137}Xe and ^{136}Xe(d,t)^{135}Xe reactions. The angular distribution data were analyzed using finite-range distorted-wave Born-approximation (DWBA) calculations corrected for nonlocality of the optical potential to extract spectroscopic information. Spin and parity assignments, excitation energies, and spectroscopic factors for most of the observed levels are presented. A ^{136}Xe(d,p) excitation function showed no significant evidence for an anomaly in the (d,p_0) cross section near the threshold of the (d,n) reaction to the corresponding isobaric analog state. (auth)

7304 A $K^\pi = 0^+$ BAND IN ^{184}W. Faler, K. T.; Spencer, R. R.; Harlan, R. A. (Idaho Nuclear Corp., Idaho Falls). Phys. Rev., 175: 1495-7(Nov. 20, 1968).

Two high-energy γ rays of 6409 ± 3 and 6290 ± 3 keV, produced following the capture of 7.6-eV neutrons by ^{183}W, populate states in ^{184}W at 1004 and 1123 keV, respectively. The spectrum of γ rays in coincidence with each of these primary γ rays was measured. These measurements result in an assignment $I^\pi = 2^+$ for the 1123-keV state and suggest that the 1004- and 1123-keV states are the $I^\pi = 0^+$ and 2^+ members, respectively, of a K = 0 band. Band-mixing calculations based on the branching ratios for decay of the 1123-keV state to members of the ground-state band were carried out, and values of the band-mixing parameter z_0 were derived. (auth)

7305 ISOBARIC ANALOG RESONANCES IN PROTON SCATTERING FROM ^{124}Te, ^{126}Te, ^{128}Te, AND ^{130}Te. Foster, J. L. Jr. (Univ. of Texas, Austin. Univ. of Pittsburgh); Riley, P. J.; Moore, C. Fred. Phys. Rev., 175: 1498-1507(Nov. 20, 1968).

Isobaric analog states were observed in proton elastic scattering from targets of ^{124}Te, ^{126}Te, ^{128}Te, and ^{130}Te. The levels thus observed in ^{125}I, ^{127}I, ^{129}I, and ^{131}I are analogs of low-lying levels of ^{125}Te, ^{127}Te, ^{129}Te, and ^{131}Te. Resonance parameters, Coulomb displacement energies, and spectroscopic factors were extracted. Results are compared with (d,p) studies on the target nuclei. (auth)

7306 DECAY STUDIES OF ^{118}I AND ^{120}I. Ladenbauer-Bellis, Inge-Maria; Bakhru, H. (Yale Univ., New Haven). Phys. Rev., 175: 1507-15(Nov. 20, 1968).

The radioactive decay of ^{118}I ground and isomeric state and ^{120}I ground and isomeric state from irradiations of Ag with ^{12}C ions, Pd with ^{14}N ions, and Cd with ^{11}B ions was studied with a Ge(Li) detector, a NaI crystal, an anthracene crystal, and several 400-channel analyzers. The electron and γ spectra, and singles and coincidence spectra, were interpreted. Tentative decay schemes for the ^{118}I ground state and isomeric state as well as the ^{120}I ground state and isomeric state are given. The half-life of ^{118g}I was found to be 13.0 ± 0.3 min (γ-ray energies: 542, 605, and 1147 keV, β^+ endpoint energy: 6.05 MeV). The half-life of the isomeric state was found to be 8.5 ± 0.5 min (γ-ray energies: 600 and 612 keV). The half-life of ^{120g}I was found to be 83 ± 4 min (γ-ray energies: 560, 640, 1520, and 1540 keV, β^+ endpoint energies: 3.45 and 2.9 MeV). The half-life of the isomeric state was found to be 53 ± 4 min (γ-ray energies: 600 and 612 keV, β^+ endpoint energy: 3.85 MeV). A comparison of the levels of ^{118,120,122,124,126}Te is given. (auth)

7307 ALPHAS BRANCHING RATIO IN THE DECAY OF ^{149}Tb. Chu, Y. Y.; Franz, E. M.; Friedlander, G. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 175: 1523-4(Nov. 20, 1968).

The 4.1-h ^{149}Tb was found to decay by α emission in 22.6 ± 2.3% of its disintegrations. This was determined by measurements of the α activity in a chemically and isotopically separated ^{149}Tb sample and by determination of the amount of ^{149}Gd formed in this sample through electron-capture decay. Branching ratios of 0.475 ± 0.055 and 0.104 ± 0.013 were deduced for the 894- and 654-keV γ rays of ^{145}Eu formed in the ^{149}Tb α decay. (auth)

7308 CHARACTERISTICS OF THE TRANSITION-STATE SPECTRA FOR ^{234}U, ^{236}U, AND ^{240}Pu FROM (d,pf) AND (t,pf) ANGULAR-CORRELATION EXPERIMENTS. Britt, H. C.; Rickey, F. A. Jr.; Hall, W. S. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 175: 1525-43(Nov. 20, 1968).

Fission-fragment angular correlations were measured as a function of the excitation energy of the fissioning nucleus for the reactions ^{233}U(d,pf), ^{235}U(d,pf), ^{239}Pu(d,pf), and ^{234}U(t,pf). A simplified microscopic model is developed and used to fit the experimental results in the energy range up to the neutron binding energy. From these fits, the positions of vibrational bands with $K = 0^+, 2^+, 0^-, 1^-$, and 2^- are determined for the transition-state spectrum of ^{234}U, ^{236}U, and ^{240}Pu. Above the neutron binding energy, the angular correlations are analyzed with a statistical model, and the pairing energy for a highly deformed transition nucleus is determined. Values obtained for the pairing gap are $2\Delta_0 = 2.10 \pm 0.15$ MeV for ^{236}U and $2\Delta_0 = 1.98 \pm 0.15$ MeV for ^{240}Pu. (auth)

7309 ^{134}Xe FROM THE DECAY OF ^{134}Cs. Alexander, E. C. Jr.; Bennett, G. A.; Srinivasan, B.; Manuel, O. K. (Univ. of Missouri, Rolla). Phys. Rev., 175: 1494(Nov. 20, 1968).

The production of ^{134}Xe from the decay of ^{134}Cs was determined by measuring the amount of ^{134}Xe in a pile-irradiated cesium salt. A branching ratio $(\lambda_{E.C.} + \lambda_{\beta^+})/\lambda_{\beta^-} = 4.5 \times 10^{-7}$ was obtained by comparing the excess ^{134}Xe with the ^{134}Cs activity. (auth)

7310 GREEN'S VELOCITY-DEPENDENT POTENTIAL IN THE SHELL MODEL OF ^{210}Po, ^{210}Pb, AND ^{210}Bi. Ganas, P. S.; McKellar, Bruce H. J. (Univ. of Sydney). Phys. Rev., 175: 1409-12(Nov. 20, 1968).

The low-lying energy levels of the odd-odd nucleus ^{210}Bi and the even-even nuclei ^{210}Po and ^{210}Pb are calculated within the framework of the harmonic-oscillator shell model taking Green's velocity-dependent N-N potential as the residual interaction. It is found that Green's parameters do not give satisfactory agreement with experiment. Sets of parameters are determined that give good fits to the experimental spectra. (auth)

7311 CALCULATION OF THE ENERGY DISTRIBUTIONS OF LIGHT NUCLEI ACCOMPANYING THE FISSION OF ^{236}U. Blocki, J.; Krogulski, T. (Inst. of Nuclear Research, Swierk, Poland). Nucl. Phys., A122: 417-24(1968).

The Geilikman model dealing with the emission of α particles in the fission of ^{236}U is modified and extended to other particles. This model treats classically the motion of the third particle in the mutual Coulomb field of the two fragments. The system of these three bodies is parametrized in terms of the initial dynamic variables, some of them are arbitrarily fitted. The calculations performed for several kinds of particles indicate that the approach which gives satisfactory fit for particles with Z = 2 demands quite different parametrization for particles with Z = 1. (auth)

7312 COINCIDENCE STUDY OF THE DECAY OF ^{146}Pm. Taylor, H. W.; Kukoc, A. H. (Univ. of Toronto). Nucl. Phys., A122: 425-30(1968).

The gamma-ray spctrum accompanying the decay of ^{146}Pm was studied with a Ge(Li)-NaI(Tl) coincidence spectrometer. Gamma rays with energies (intensities) of 146.2 ± 1.3 (0.33), 453.7 ± 0.4 (100), 589.8 ± 0.7 (0.55), 633.1 ± 0.5 (3.6), 735.6 ± 0.7 (36.4) and 747.0 ± 0.8 (58.7) keV were observed. The decay scheme of ^{146}Pm was constructed with levels in ^{146}Nd at 453.7 ± 0.4, 1043.5 ± 0.8 and 1189.5 ± 0.9 keV and in ^{146}Sm at 747.0 ± 0.8 and 1380.1 ± 0.9 keV. (auth)

7313 MIXING OF ROTATIONAL BANDS IN ^{160}Dy. Guenther, C. (California Inst. of Tech., Pasadena); Ryde, H.; Krien, K. Contract AT(04-3)-63. Nucl. Phys., A122: 401-16(1968).

Low-lying negative-parity states in ^{160}Dy have been interpreted as members of two strongly mixed rotational bands. The mixing amplitudes in the wave functions for the various states are calculated from the level energies. All the observed transition probabilities can be shown to be consistent with this interpretation. (auth)

7314 NUCLEAR DEFORMATIONS IN THE PAIRING-PLUS-QUADRUPOLE MODEL. V. ENERGY LEVELS AND ELECTROMAGNETIC MOMENTS OF THE W, Os, AND Pt NUCLEI. Kumar, Krishna (Massachusetts Inst. of Tech., Cambridge. Michigan State Univ., East Lansing); Baranger, Michel. Contracts AT(30-1)-2098; AT(11-1)-1051. Nucl. Phys., A122: 273-324(1968).

The low-lying even-parity energy levels and wave functions of the even isotopes of Os, Pt, and W are calculated within the framework of Bohr's collective Hamiltonian. The six kinetic energy functions and the potential energy function which enter the Hamiltonian, and which determine the coupling between rotational motion β-vibrations and γ-vibrations, are derived microscopically by using the pairing-plus-quadrupole model of residual interactions. Couplings between the three kinds of motion are treated exactly, and a numerical method is used to solve the Schroedinger equation. At the low-A end of the W-Os-Pt region, there are large deviations from the rotational model; the β-γ-bands are strongly mixed. At the high-A end, there are large deviations from the phonon model; the wave functions are smeared over all possible shapes, and a large, positive quadrupole moment of the first 2^+ state of ^{196}Pt is predicted. Many energy levels, B(E2) values, quadrupole moments, B(M1) values, magnetic moments, electric monopole transitions and nuclear shape fluctuations are also predicted. (auth)

7315 PARTICLE-HOLE MULTIPLETS IN ^{208}Bi. Kuo, T. T. S. (Princeton Univ., N. J. Argonne National Lab., Ill.). Nucl. Phys., A122: 325-42(1968).

The energy levels of ^{208}Bi are calculated with the reaction matrix elements deduced from the Hamada-Johnston potential and are compared with the recent experimental data of Alford, Schiffer, and Schwartz. The calculated wave functions for most low-energy states show very little configuration admixture. The energy levels were calculated with and without the inclusion of the core-polarization effects, and the results of the two calculations show no significant difference. Remarkable agreement with experiment is obtained for all 36 experimentally identified low-energy levels. But a large discrepancy is observed for the isobaric analogue state of ^{208}Pb, the calculated position being about 4 MeV too low. A multipole analysis of the effective particle-hole interactions was carried out. (auth)

7316 ANGULAR ANISOTROPY OF FISSION OF ^{238}U BY NEUTRONS NEAR THRESHOLD. Androsenko, Kh. D.; Smirenkin, G. N. JETP Lett. (USSR) (Engl. Transl.), 8: 108-10(Aug. 20, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 181-5(Aug. 20, 1968).

The angular distributions of fragments from the fission of ^{238}U by 0.8- to 3.4-MeV neutrons were measured using glass detectors. The results are in agreement with statistical theory not only near

the threshold but also in the essentially subthreshold region. The data for 0.5 to 0.7 MeV below the threshold are interpreted in terms of a two-humped deformation–potential energy curve. (D.C.W.)

7317 SECOND-ORDER EFFECTS IN ELASTIC AND INELASTIC SCATTERING OF DEUTERONS AND PROTONS. Bang, J. M.; Chan, K. Y.; Kurepin, A. B.; Saethre, Oe. (Niels Bohr Inst., Copenhagen. NORDITA, Copenhagen). Nucl. Phys., A122: 34-48(1968).

A second-order Born approximation for elastic and inelastic scattering is evaluated and applied to elastic scattering and double excitations of rotational states by protons and deuterons. The calculations are compared to experiments made with the tandem accelerator of the Niels Bohr Institute. Information is obtained about the quadrupole and hexadecapole deformations as well as other parameters of nuclei in the deformed region. (auth)

7318 HALF-LIFE OF THE 1552-keV LEVEL IN ^{234}U. Loebner, K. E. G. (Institut voor Kernphysisch Onderzoek, Amsterdam. Technical Univ., Munich); Goudsmit, P. F. A.; Konijn, J.; Lingeman, E. W. A.; Polak, P. Nucl. Phys., A122: 214-19(1968).

The half-life of the 1552-keV level in ^{234}U was measured in the decay of 6.7 hr ^{234}Pa by delayed coincidences with a time-to-amplitude converter to be 2.20 ± 0.25 ns. This half-life determines the transition probability of the 131-keV E1 transition between the two neutron states $5^+\{\frac{5}{2}^+[622]\uparrow + \frac{5}{2}^+[633]\downarrow\}$ and $6^-\{\frac{7}{2}^-[743]\uparrow + \frac{5}{2}^+[633]\downarrow\}$. The hindrance factors ($F_W = 3.5 \times 10^4$ and $F_N = 0.27$) are compared to those of the E1 transition between the same Nilsson states in the odd-mass nucleus ^{239}Pu ($F_W = 2.2 \times 10^6$ and $F_N = 13$). The difference of the reduced transition probabilities is discussed in terms of pairing interactions. It was confirmed that the 1552-keV level is only depopulated by the 131-keV E1 transition. (auth)

7319 LEVEL SCHEME OF ^{147}Sm AND g-FACTORS OF ITS TWO LOWEST EXCITED STATES. Bozek, E.; Broda, R.; Golczewski, J.; Hrynkiewicz, A. Z.; Kulessa, R.; Niewodniczanski, H.; Rybicka, M.; Walus, W. (Inst. of Nuclear Physics, Krakow. Jagellonian Univ., Krakow). Nucl. Phys., A122: 184-92(1968).

The level scheme of ^{147}Sm was investigated by the method of gamma-gamma coincidence. New levels at 1200, 1300, and 1395 keV were deduced. The existence of the 1180- and 1228-keV levels, which were tentatively introduced previously, is questioned. The lifetimes of the 122- and 198-keV states were remeasured as τ(122 keV) = 1.15 ± 0.06 ns and τ(198 keV) = 1.95 ± 0.15 ns. The g-factors of the 122- and 198-keV states were determined by observing the integral rotation of the angular correlations in an external magnetic field. The obtained results g(122) = −0.12 ± 0.07 and g(198) = −0.19 ± 0.07 are compared with theoretical predictions based on the calculations of Kisslinger and Sorensen. (auth)

7320 ANGULAR CORRELATION MEASUREMENTS IN ^{192}Pt. Hamilton, W. D.; Davies, K. E. (Univ. of Sussex, Brighton, Eng.). Nucl. Phys., A122: 165-76(1968).

Gamma-gamma and γ–linear polarized γ angular correlation measurements were used to determine the E2 : M1 multipole mixing ratio of the 296 ($2^+ \rightarrow 2^+$) 308 ($3^+ \rightarrow 2^+$) and 604 ($3^+ \rightarrow 2^+$) keV transitions in ^{192}Pt. A Ge detector was used in conjunction with a NaI detector to resolve the complex spectra of the γ-γ correlations. The linear polarization measurements were carried out at a correlation angle of 90° using a summing polarimeter. The measurements are consistent with the accepted spins of the levels involved and yield the following values of the E2 : M1 mixing ratio δ: δ(296) = −9.0 to −11.0; δ(308) = −6.5 to −8.3; and δ(604) = +1.9 to +2.4. (auth)

7321 PRECESSION MEASUREMENTS FOLLOWING COULOMB EXCITATION WITH OXYGEN IONS. VII. PRECESSION MEASUREMENTS ON NUCLEI RECOILING INTO GAS AND THE GYROMAGNETIC RATIO OF THE FIRST EXCITED 2^+ STATE IN ^{150}Nd. Ben-Zvi, I.; Gilad, P.; Goldberg, M.; Goldring, G.; Sprinzak, A.; Vager, Z. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., A122: 73-80(1968).

A precession measurement is reported for the 2^+ state at 132 keV in ^{150}Nd. A suitable environment of low perturbation was provided by letting the excited nuclei recoil into argon. The decay of the recoiling nuclei was observed in flight. A further property of this environment is that the precession of the excited nuclei is due to the externally applied magnetic field only; the paramagnetic amplification associated with an atomic environment at thermal equilibrium is absent in this case. The measured g-factor is g(^{150}Nd) = 0.333 ± 0.051. (auth)

7322 AN EXPERIMENTAL TEST OF DISTORTED WAVE THEORY. Michelman, Lionel Steven. New Brunswick, N. J., Rutgers - The State Univ., 1968. 206p. Thesis.

The polarization of protons from the ground state and second excited state (1.2 MeV) from the reaction ^{90}Zr(d,p)^{91}Zr was measured over the angular range of 40 to 130°, using 11-MeV deuterons. A series of DWBA calculations were made using optical model parameters obtained from elastic deuteron scattering cross-section measurements on ^{90}Zr at 11 MeV and elastic proton scattering cross-section and polarization measurements at 16.0 and 14.8 MeV, which corresponded to emergence energies of the (d,p) protons from the ground and second excited states, respectively. Elastic proton scattering cross measurements which were made over the energy range of 14.4 to 16.4 MeV at 130, 150 and 170°, turned out to have a smooth variation with energy, indicating that the DWBA direct reaction theory should have been appropriate. The results of these calculations were in good agreement with the reaction cross sections which were also measured. However, there was considerable disagreement between the proton polarization predictions and measurements. The ground state ($l_n = 2$) polarizations turned out to be very small out to 90°, however, past 100° some sizable polarizations were measured. These back angles were the only ones which agreed with the theory for this state. For the 1.2-MeV level, there is no orbital angular momentum transfer ($l_n = 0$); and the polarization should then depend primarily on the spin-orbit terms in the optical potentials. Data for this state showed sizable fluctuations over the whole angular range measured, which agreed with the theory in respect to the frequency of the oscillations but not in magnitude. (Diss. Abstr.)

7323 PROTON SCATTERING FROM EVEN TIN, CADMIUM, AND TELLURIUM ISOTOPES. Makofske, William Joseph. New Brunswick, N. J., Rutgers - The State Univ., 1968. 166p. Thesis.

Differential cross sections were measured for 16-MeV elastic and inelastic proton scattering from ^{112,116,118,120,122,124}Sn, ^{110,112,114,116}Cd, and ^{126,128,130}Te. For each set of isotopes, the oscillatory structure of the elastic scattering angular distributions is systematically damped with increasing neutron number, and the entire pattern moves to smaller angles due to a size effect. The inelastic scattering leading to the first 2^+ and 3^- collective states for each set of isotopes generally exhibits a systematic decrease in magnitude with increasing A, although the angular distributions are quite similar for each type of state. This variation cannot be explained entirely in terms of the known decrease in collectivity of these states with increasing A. Interpreting the increased damping of the elastic cross sections with increasing A in terms of an increase in the surface imaginary part of the optical potential W_D, a coupled-channel analysis on ^{112}Sn and ^{124}Sn, using published electromagnetic β_2's, was able to reproduce the experimental results with a 20% variation in W_D. Optical model calculations for all the nuclei were made using a few fixed geometries, and searching on V and W_D. The parameters of the spin-orbit term were held constant at $V_{so} = 6$ MeV, $\alpha_{so} = .7$f, $r_{so} = 1.1$f. Good overall fits were obtained for the Cd and Sn isotopes using $r_0 = 1.2$f, a = .7f, ro′ = 1.25f, and a′ = .65f. The Te isotopes required a slightly different geometry, with $r_0 = 1.2$f, a = .75f, ro′ = 1.25f, and a′ = .625f. The V and W_D tended to be systematic, increasing with increasing (N-Z)/A for each set of isotopes. The major exception to this trend consisted of ^{118}Sn, which exhibited an anomalously large elastic cross section. This was verified by three separate measurements on different targets. The increase of V and W_D with (N-Z)/A is consistent with an isospin dependence in both the real and imaginary part of the optical potential. A least-square fit to the data indicated a strength of the symmetry term in the real part of the optical potential of 16 MeV for Cd and Sn, and 27 MeV for Te. For the imaginary part, it was 23 MeV for Cd and Sn, and 44 MeV for Te. The distorted-wave program DWUCK, including a complex form factor and Coulomb excitation, was run assuming a collective vibrational model. Deformation parameters for all the 2^+ and 3^- states were extracted by normalizing the inelastic output to the experimental inelastic cross sections. The parameters, with the exception of ^{118}Sn, are systematic for each type of state in a given set of isotopes, exhibiting a decreasing magnitude with increasing A. A comparison with δ_2's and δ_3's measured by other techniques yields serious discrepancies. The Sn isotopes exhibited a greater range of collectivity for both δ_2 and δ_3 values than previous measurements indicate. Furthermore, the δ_2's for cadmium decrease with increasing A, while electromagnetic δ_2's increase with increasing A. These can not be reconciled within the estimated errors. A comparison with calculated B(E2)'s and B(E3)'s for Sn and B(E2)'s for Cd and Te, show that the experimental results for proton scattering generally do not agree well with theoretical electromagnetic transition rates, although recent results indicate a decreasing trend with increasing A for the B(E2) values of ^{116}Sn, ^{118}Sn, and ^{120}Sn. (Diss. Abstr.)

7324 PARTICLE VIBRATION COUPLING IN ^{207}Pb. Grosse, E.; Moore, C. F.; Solf, J.; Hering, W. R.; von Brentano, P. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Phys., 218: 213-16(1969).

States in ^{207}Pb were observed in the proton decay of the lowest 5^- and 4^- analog resonances in ^{208}Bi. Evidence is given that one group of these states corresponds to the ^{206}Pb(2^+,0.8) ⊗ $g_{9/2}$ and ^{208}Pb(3^-,2.6) ⊗ $p_{1/2}^{-1}$ multiplets. (auth)

7325 THE PREPARATION OF ^{145}Pm FROM NEUTRON-IRRADIATED ^{144}Sm. Pinajian, J. J.; Raman, Subramanian (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 30: 3151-3 (Dec. 1968).

Millicurie amounts of 18-yr ^{145}Pm were prepared by ^{144}Sm(n,γ) ^{145}Sm $\xrightarrow{EC}$ ^{145}Pm by utilizing a total integrated thermal neutron flux of ≈ 2.4×10^{22} n/cm^2. The ^{145}Pm activity was chemically isolated by cation chromatography. High-resolution measurements with a Ge(Li) crystal showed gamma rays of energies 67.0 ± 0.2 keV and 72.2 ± 0.2 keV associated with ^{145}Pm decay. The ratio of the photon intensities I(72.2)/I(67.0) = 3.0 ± 0.5. (auth) (UK))

7326 14.8-MeV NEUTRON CROSS SECTIONS FOR (n,^{3}He) AND OTHER RARE NUCLEAR REACTIONS ON ^{103}Rh. Husain, L.; Bari, A.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). J. Inorg. Nucl. Chem., 30: 3145-9(Dec. 1968).

The 14-MeV neutron cross sections for the rare nuclear reactions (n,^{3}He), (n,2p), and (n,n′α) on ^{103}Rh were measured by isolating the products radiochemically and counting the beta and gamma activities. The following results were obtained: ^{103}Rh(n,^{3}He) ^{101}Tc, 2.0 ± 0.6 μbarn; ^{103}Rh(n,2p)^{102m}Tc, 7 ± 4 μbarn; and ^{103}Rh (n,n′,α)^{99m}Tc, 65 ± 15 μbarn. (auth) (UK)

7327 CHARGE DISTRIBUTION IN THE FISSION OF ^{238}U. Anderson, J. L.; Freid, S. H.; Choppin, G. R. (Florida State Univ., Tallahassee). J. Inorg. Nucl. Chem., 30: 3167-72(Dec. 1968).

The nuclear charge distribution in the fission of ^{238}U by 9.5-MeV and 11.3-MeV protons and 11.5-MeV deuterons was studied from the yield of 12 shielded or quasi-shielded nuclides. Correlation with a Gaussian charge dispersion was investigated for various mass formulas, neutron distribution functions, and charge distribution hypotheses. Both the proton- and deuteron-induced fission of ^{238}U showed best correlation with the minimum potential energy postulate of charge distribution using a shell-effected mass equation and a "saw-tooth" neutron distribution. (auth) (UK)

7328 CHARGE DISTRIBUTION IN THE FISSION OF ^{232}Th. Freid, S. H.; Anderson, J. L.; Choppin, G. R. (Florida State Univ., Tallahassee). J. Inorg. Nucl. Chem., 30: 3155-65(Dec. 1968).

The yields of ten shielded or quasi-shielded nuclides in the fission of ^{232}Th by 9.5-MeV and 11.3-MeV protons and 11.5-MeV deuterons were determined in order to study the distribution of nuclear charge. Various mass formulas, neutron distribution functions, and postulates of charge distribution functions were tested for correlation with the experimental data. It was found that a "saw-tooth" neutron function with a shell-effected mass equation gave the "best fit" to a Gaussian distribution when the equal charge displacement postulate was used to describe the proton-induced fission and when the minimum potential energy postulate was used to describe the deuteron-induced fission. (auth) (UK)

Nuclear Theory

Refer also to abstracts 7102, 7218, 7222, 7226, 7228, 7231, 7248, 7253, 7282, 7294, 7310, 7314, and 7315.

7329 (INR-932) CALCULATION OF THE ENERGY DISTRIBUTIONS OF LIGHT NUCLEI ACCOMPANYING THE FISSION OF ^{236}U. Blocki, J.; Krogulski, T. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 18p. Dep.

The Geilikman model dealing with the emission of α particles in the fission of ^{236}U was modified and extended to other particles. This model treats classically the motion of the third particle in the mutual Coulomb field of the two fragments. The system of these three bodies is parametrized in terms of the initial dynamic variables, some of them arbitrarily fitted. The calculations performed for several kinds of particles indicate that the approach which gives satisfactory fit for particles with Z = 2 demands quite different parametrization for particles with Z = 1. (auth)

7330 (KFKI-28/1968) A UNIFIED THEORY OF THE COMPOUND AND THE INTERMEDIATE RESONANCES. Dolinszky, T. Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1968. 16p. Dep.

To account for the compound resonances that are usually averaged out in the theories of the intermediate structure but extractable from recent detailed high resolution measurements covering a wide energy range the interior contribution to the transition matrix is factorized into a regular and an irregular function of energy. While the latter is expanded in terms of the poles in the energy plane the former is developed into a series with energy-dependent shell-model eivenvalues, belonging to excitations of various complexity, in the energy denominators. This formula implies, apart from the simultaneous exhibition of the compound levels and the doorway structure, also the approximate zeros of the partial cross section. A systematic shift between the partial cross-section zeros in elastic scattering and the proper poles establishes a connection between the regular factor as well as the pole factor and gives rise to an arrangement of the compound levels among the optical resonances. (auth)

7331 INVESTIGATION OF HEAVY NUCLEI WITH SHARP SENIORITY WAVE FUNCTIONS AND COMPARISON TO THE BCS APPROXIMATION. Garcia, J.; Schuette, D. (Univ., Bonn). Nucl. Phys., A121: 535-42(1968).

Within a realistic model for heavy spherical nuclei, a numerical comparison of the results of the BCS approximation and the seniority 0 and 1 approximation is performed in a detailed way. It is shown that for the characteristic pairing properties there is a good agreement between both computational methods for this range of nuclei if one takes realistic single-particle energies and pairing matrix elements into account. (auth)

7332 PEAR-SHAPED DEFORMATION IN OSCILLATOR MODEL. Lee, Kiuck; Heartle, Thomas C. (Marquette Univ., Milwaukee). Nucl. Phys., A121: 543-8(1968).

Fourth-order perturbation calculations were carried out in order to determine the stability of the pear-shaped deformations using the deformation potential of Lee and Inglis and the harmonic oscillator representation without spin-orbit coupling. The resulting perturbation energy g^4 is proved to be negative for the sample nuclei considered, thus making it possible to complete with the second-order energy which is positive. The value of pear-shapedness parameter $g(\hbar/M\omega_0)^{1/2}$ for which the sign of the total perturbation energy turns negative is approximately 0.15 for heavy nuclei while it is approximately 0.5 for light nuclei, thus suggesting that such deformations may be stable in heavy nuclei only. The contributions from the terms in g^6 and of higher order are also estimated and expected to be small. (auth)

7333 THE STATISTICAL CALCULATION OF THE DENSITY OF DOORWAY STATES AND THE PROBLEM OF THEIR EXPERIMENTAL DETECTION. Breunlich, W. H. Oesterr. Akad. Wiss., Math.-Naturwiss. Kl., Sitzungsber. Abt. II, 176: 245-52(1968). (In German).

An intermediate nucleus in nuclear reactions can be formed by the incident particle yielding part of its energy to another nucleon, which becomes excited and leaves behind a hole. This 2-particle–1-hole state is known as a "doorway state." Only two types of doorway states can be distinguished: one in which both excited nucleons are in bound states and one in which one nucleon is in a virtually unbound level. The density of doorway states in a Fermi gas model was calculated. The density has a maximum at U = B (where U = excitation energy and B = binding energy) and decreases linearly compared with U = 2B to a zero value. For U > 2B, only that state is possible in which at least one particle has a virtually unbound level. The decay mechanisms of doorway states are discussed in view of their experimental detection. (J.S.R.)

7334 MICROSCOPIC THEORY OF EFFECTIVE OPERATORS FOR ELECTROMAGNETIC INTERACTIONS IN NUCLEI. Gmitro, M. (International Centre for Theoretical Physics, Trieste, Italy); Rimini, A.; Sawicki, J.; Weber, T. Phys. Rev., 175: 1243-52 (Nov. 20, 1968).

Effective operators for valence (open-shell) nucleons are constructed for electromagnetic interactions in nuclei. Such operators are calculated in terms of excitations and deexcitations of particle-hole pairs of the core nucleons. The nuclear force involved here is a realistic nucleon-nucleon potential (Yale-Shakin). The theory is applied to the tin isotopes which are described in terms of five valence neutron subshells and of all the core and empty subshells of both the neutrons and protons between the magic numbers 8 and 126. The effective quadrupole charge matrix, with all its elements of about the same order of magnitude, gives the first partial support to the concept of a constant neutron effective charge. Calculations of observables are performed with the states of the even tin isotopes described in terms of the two- and four-quasiparticle Tamm–Dancoff theories involving explicitly only the valence neutrons. Results are presented for the B(E2, $2_1^+ \rightarrow 0_1^+$), the quadrupole moment Q(2_1^+), the gyromagnetic factor $g_{2_1^+}$, and the inelastic electron scattering form factors for the 2_1^+ and 3_1^- states of ^{116}Sn. Ex-

cept for the last (3_1^-) form factor, good semiquantitative agreement with all the corresponding experimental data is obtained. The reported calculations involve no ad hoc adjustable parameters. (auth)

7335 REGGE-TYPE REPRESENTATIONS FOR COULOMB-NUCLEAR S-MATRIX. Shastry, C. S.; Satpathy, R. K. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., 175: 1544-52 (Nov. 20, 1968).

Using a Yukawa-type "nuclear" potential, Regge poles and residues of the Coulomb-nuclear S matrix are calculated for various strengths of the repulsive Coulomb interaction. Partial-wave amplitudes and residues generated by different Regge-type representations are then compared with the exact results. Calculations are performed using both "sum-type" and "product-type" representations. These results are helpful in establishing the usefulness and validity of the Regge-pole approach to charged-particle–nucleus scattering. (auth)

7336 SEPARABLE-POTENTIAL FITS TO NUCLEON–NUCLEON SCATTERING DATA. Mongan, Thomas R. (Univ. of California, Berkeley). Phys. Rev., 175: 1260-74(Nov. 20, 1968).

The Arndt–MacGregor (Livermore) nucleon-nucleon phase shifts and mixing parameters for partial waves through $J = 4$ were fitted in the energy range 0 to 400 MeV by separable potentials. Partial-wave scattering amplitudes were permitted to have singularities only for real negative values of the complex energy variable, in addition to the usual right-hand unitarity cut guaranteed by the Lippman-Schwinger formalism. The appropriate partial-wave amplitudes contain the deuteron pole and the singlet antibound-state pole at the correct energies. The use of these fits in probing the off-energy-shell behavior of scattering amplitudes is discussed. (auth)

7337 SCATTERING OF MEDIUM-ENERGY ALPHA PARTICLES. I. PHENOMENOLOGICAL ANALYSIS OF ELASTIC SCATTERING. Jackson, Daphne F.; Morgan, C. G. (Univ. of Surrey, Eng.). Phys. Rev., 175: 1402-8(Nov. 20, 1968).

Several discrete sets of optical potentials which fit the data on the elastic scattering of medium-energy α particles are examined. It is shown that the usual criterion for equivalence of these potentials is valid only if little variation is allowed in the diffuseness parameter, and that a more widely applicable criterion is obtained by considering the magnitudes of the potentials at the strong-absorption radius. It is also shown that, because of the ambiguities in the optical potential for α particles, the half-way radius and the equivalent radius of the potentials are functions of the depth and therefore cannot be regarded as significant nuclear size parameters. The strong-absorption radius, however, is shown to be a very significant size parameter, which can be related not only to the reflection coefficients but also to the optical-model wave function. (auth)

7338 VARIATIONAL METHODS IN NUCLEAR PAIRING THEORY. Baumgaertner, German (Technische Hochschule, Munich). Z. Phys., 218: 266-72(1969).

Particle-number conserving ground-state wave functions are constructed by use of the Thouless-Peierls formalism. A comparison with PBCS and FBCS solutions shows an encouraging advantage of this method: the ground state is lower in energy than the FBCS ground state and the computer time necessary to obtain the ground-state wave function as well as its energy is smaller than with the FBCS method. (auth)

7339 METHODS FOR CALCULATING GROUND-STATE CORRELATIONS OF VIBRATIONAL NUCLEI. Rowe, D. J. (Univ. of Rochester, N. Y.). Phys. Rev., 175: 1283-92(Nov. 20, 1968).

Various methods are investigated for calculating correlated ground states and their one-particle densities, with a view to including correlation effects in higher random-phase-approximation (RPA) calculations. The problem of the divergent correlations associated with the center-of-mass and other spurious RPA solutions is discussed and it is shown that they can simply be ignored. (auth)

7340 INVESTIGATION OF GROUND-STATE CORRELATIONS FOR A MODEL HAMILTONIAN OF THE NUCLEUS. Parikh, J. C.; Rowe, D. J. (Univ. of Rochester, N. Y.). Phys. Rev., 175: 1293-1300(Nov. 20, 1968).

The importance of ground-state correlations in the spectroscopy of a finite many-particle system, such as the nucleus, was investigated for the model Hamiltonian of Lipkin, Meshkov, and Glick. In particular, their effect on the solution of the equations of motion for excitation energies, transition matrix elements, and the correlation energy of the ground state was investigated. Methods were studied for calculating the correlations needed to make the necessary corrections to the equations of motion. Also studied was the behavior, with increase of interaction strength, of the phase transition from the spherical to the strongly deformed intrinsic states, in the projected Hartree-Fock scheme. (auth)

7341 GELL-MANN–GOLDBERGER RELATION FOR REACTIONS OF THE FORM (d,pn). Vincent, C. M. (Argonne National Lab., Ill.). Phys. Rev., 175: 1309-13(Nov. 20, 1968).

For the breakup of a particle d into its constituents n and p in the field of a nucleus A, a Gell-Mann–Goldberger relation is derived for which the first potential excludes the np interaction. Effects of the recoil and structure of A are neglected. The limit problems that arise in the use of Lippmann-Schwinger equations with three-particle final states are treated for the case of short-range forces, and the discussion is extended to include Coulomb forces. The final exact "post" form of the transition matrix element resembles the distorted-wave Born approximation result given by Huby and Mines, and may be considered a justification of it. (auth)

7342 SHELL MODEL IN THE CONTINUUM: APPLICATION TO THE FOUR-NUCLEON SYSTEM. Huefner, Joerg; Shakin, C. M. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 175: 1350-8(Nov. 20, 1968).

The continuum shell model was applied to the study of the elastic scattering of protons from ^{3}He as well as to the photodisintegration of ^{4}He. A semiquantitative fit was obtained for the scattering phases and the photoabsorption cross section using a model Hamiltonian consisting of a real, local potential and a finite-range effective interaction. Two approximations for the total wave function of the system were studied, and it was found that the photoabsorption cross section is sensitive to the approximation used, while the calculated scattering phases are fairly independent of the details of the wave function. A method for improving the convergence of the Born series is proposed which was found to be useful in this calculation. (auth)

7343 USE OF A TRUNCATED HILBERT SPACE IN NUCLEAR REACTION CALCULATIONS. Huefner, Joerg (Massachusetts Inst. of Tech., Cambridge); Lemmer, R. H. Contract AT(30-1)-2098. Phys. Rev., 175: 1394-1402(Nov. 20, 1968).

This formulation of nuclear reaction calculations stays as close as possible to the usual bound-state shell-model calculations. The Hilbert space used in the bound-state calculations is enlarged by adding the scattering states only at that energy for which the reaction is calculated. This Hilbert space is finite-dimensional. The eliminated Hilbert space is partly accounted for by an effective interaction. A variational principle is used to derive the equations for the K- and the S-matrix, which are then solved by algebraical methods. The numerical application of this method to the reaction ^{15}N(n,n′)^{15}N shows good agreement with the results of previous calculations. (auth)

7344 HIGH-ENERGY NUCLEUS–NUCLEUS COLLISIONS. I. GENERAL THEORY AND APPLICATIONS TO DEUTERON–DEUTERON SCATTERING. Franco, Victor (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 175: 1376-93(Nov. 20, 1968).

A theoretical analysis of the collisions of high-energy nuclei with nuclei is carried out by means of a simple extension of the Glauber approximation. Effects of multiple collisions are taken into account. The general formalism is applied to deuteron-deuteron collisions. Expressions are derived for single-, double-, triple-, and quadruple-scattering amplitude operators for deuteron-deuteron collisions in terms of nucleon-nucleon scattering amplitude operators. A new type of double-scattering effect, qualitatively quite different from the Glauber "shadow" effect which was discovered for particle-deuteron collisions, is described. For the case of nucleon-nucleon interactions described by purely absorbing (black) spheres, it corresponds qualitatively to a "double-counting" correction in the deuteron-deuteron absorption cross section. This effect corresponds to collisions in which one nucleon in the incident deuteron interacts with only one nucleon in the target, and the other nucleon in the incident deuteron interacts with only the other nucleon in the target. The formalism is applied to a calculation of the deuteron-deuteron total cross section σ_{dd}. It is shown that the contribution to σ_{dd} arising from the new type of double-scattering correction is approximately 50% of that arising from the usual (i.e., shadow-type) double-scattering correction. Numerical results are compared with measurements. A simple analysis of the deuteron-deuteron elastic scattering angular distribution is presented. It is shown that for a rather large range of scattering angles away from the forward direction, double scattering is the dominant process in elastic scattering, and that in this region the new type of double scattering is quantitatively much more important than the usual double-scattering process which also appears in nucleon-deuteron collisions. (auth)

7345 STATIC COULOMB CORRECTIONS TO THE POINT-NUCLEUS FERMI FUNCTION IN NUCLEAR BETA DECAY. Logue, L. J.; Chern, B. (Univ. of Florida, Gainesville). Phys. Rev., 175: 1367-75(Nov. 20, 1968).

A simple model to include the effects of nuclear charge change in β decay is described. The point-nucleus Fermi function for the daughter nucleus in perturbation theory to $Z^2\alpha^2$ and corrections to it arising from the change in nuclear charge are developed. The model considers only Coulomb interactions between the static parent-daughter nucleus with the leptons and allows for pair creation. This model has been used by Chern et al., and by Halpern and Chern to obtain analytical model dependences of the finite nuclear size, screening, and static β-vertex correction to first order in α. The divergences in the Fermi function are shown to have the same source as the divergences occurring in this model due to the change in nuclear charge, so that both types of divergence must be treated in the same manner, including the use of the same cutoff. It is found that the $Z\alpha^2$ contribution to the transition probability per unit time calculated from this model is comparable to the screening correction, and thus must be included if one takes the screening into account. An uncertainty has arisen in the literature concerning the incorporation of the first-order radiative correction into the Fermi function. It is found that the approximate factorization previously used in the literature to order α is also valid to order α^2 for nuclei with Z less than that of ^{26}Al. The validity of this factorization for higher Z is still unresolved. (auth)

7346 BINDING ENERGIES OF OPEN-SHELL NUCLEI. Dworzecka, Maria; Warke, Chindhu S. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 175: 1346-9(Nov. 20, 1968).

The binding energies of open-shell nuclei (2s-1d) are calculated from the approximate Hartree-Fock solution along with the use of the projection technique, both for the Yale potential and for a nonlocal separable potential. It is observed that though the Yale potential gives better binding than the nonlocal potential does, it still gives lower values than the experimental numbers, as was the case for the ^{16}O nucleus. (auth)

7347 INVESTIGATION OF NUCLEAR THREE- AND FOUR-BODY SYSTEMS WITH SOFT-CORE NUCLEON-NUCLEON POTENTIALS. Afnan, I. R.; Tang, Y. C. (Univ. of Minnesota, Minneapolis). Phys. Rev., 175: 1337-45(Nov. 20, 1968).

The nuclear three- and four-body systems were investigated with a variational method and various soft-core nucleon-nucleon potentials. A Monte Carlo method was used to compute the multidimensional integrals involved. The results show that a soft-core potential and a hard-core potential which give the same effective-range parameters and S-wave phase shifts yield very nearly the same values for the binding energies and rms radii of ^{3}H and ^{4}He, and as far as the ground-state properties of ^{3}H and ^{4}He are concerned, the fitting of the high-energy ($\gtrsim$100-MeV) s-wave phase shifts need not be seriously considered in choosing a nucleon-nucleon potential. Also, it is shown that by paying less attention to the higher-energy ($\gtrsim$50-MeV) nucleon-nucleon scattering data, a soft-core potential can be found which yields nearly correct values for the binding energies, rms radii, and form factors up to about 10 F^{-2} for both ^{3}H and ^{4}He. The soft-core potentials proposed by Eikemeier and Hackenbroich and by Volkov were also briefly considered. Here the results indicate that the mathematical approximations used by Hackenbroich et al., to investigate the properties of light nuclei are inaccurate, while the binding energy of ^{4}He calculated by Volkov is too small by about 2 MeV. (auth)

7348 MODEL DEPENDENCE OF CORRECTIONS TO THE FERMI FUNCTION AND ft VALUES OF SOME $0^+ \rightarrow 0^+$ SUPER-ALLOWED β DECAYS, AND THE VALUE OF THE VECTOR COUPLING CONSTANT. Halpern, T. A.; Chern, B. (Univ. of Florida, Gainesville). Phys. Rev., 175: 1314-29(Nov. 20, 1968).

A consistent field-theoretic perturbative calculation of the Fermi function and the analytical model dependences of corrections to it is described. The screening, finite nuclear size, and radiative corrections were considered in a unified treatment. It was possible to separate out the point-nucleus Fermi function F_0 from the corrections, and thus only treat the corrections in a power-series expansion. The proper way of incorporating the radiative correction into F_0 is discussed. Detailed analytical results for the model dependence of the finite-nuclear-size and radiative corrections are presented. The most realistic model chosen employed the nuclear charge distributions as given by Hofstadter and the single-particle harmonic-oscillator model for the nuclear matrix elements. The model-dependent results were used to calculate the ft values of the super-allowed decays of ^{14}O, ^{26}Al, Cl^{34}S, ^{42}C, ^{46}V, ^{50}Mn, and ^{54}Co. The values of the vector coupling constant G_V were calculated for the above nuclei using the most realistic model, and the variation of the G_V is discussed in the light of the predictions of the conserved-vector-current theory of weak interactions. (auth)

7349 STRETCH SCHEME VS SENIORITY SCHEME FOR A SIMPLE SYSTEM OF PROTONS AND NEUTRONS. Gillet, Vincent; Raynal, Jacques (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Nucl. Phys., A122: 193-213(1968).

In the framework of a simple model of Z protons and N neutrons in single shells respectively, the ground-state energies given by the stretch scheme and the seniority scheme are compared. The competition between the two schemes is dominated by the triplet even force which favors a deformed ground state and the singlet even force which favors a spherical ground state, whatever be the range of the force and the neutron-proton excess. Mixing between the two states is small. (auth)

7350 INTERNAL BREMSSTRAHLUNG AND IDENTIFICATION OF THE MECHANISM OF BINARY DIRECT REACTIONS. Dubovoi, E. I.; Shapiro, I. S. JETP Lett. (USSR) (Engl. Transl.), 8: 130-3(Aug. 20, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 216-19(Aug. 20, 1968).

A method of identifying reaction mechanisms on the basis of the extrema in the energy spectrum of the internal bremsstrahlung is outlined. (D.C.W.)

7351 NUMERICAL TABLES FOR ANGULAR CORRELATION COMPUTATIONS IN α-, β-, AND γ-SPECTROSCOPY: 3j-, 6j-, 9j-SYMBOLS, F- AND Γ-COEFFICIENTS. Appel, H. Landolt-Boernstein. Numerical Data and Functional Relationships in Science and Technology. New Series. Group 1. Nuclear Physics and Technology. Volume 3. New York, Springer-Verlag, 1968. 1208p.

Tables of coefficients for the calculation of angular correlations in α, β, and γ spectroscopy are presented. The angular correlation formalism is outlined, together with the definition and properties of the tabulated coefficients. (D.C.W.)

7352 TABLITSY 9j-KOEFFITSIENTOV DLYA TSELYKH ZNACHENII PARAMETROV S ODNIM PARAMETROM, RAVNYM EDINITSE. (Tables of 9j-Coefficients for Integral Values of the Parameters with One Parameter Equal to Unity). Jucys, A. (ed.). Moscow, Vychislitel'nyi Tsentr AN SSSR, 1968. 580p.

Tables are given for values of the 9j symbol for integral values of the parameters with one parameter equal to unity. (J.W.R.)

7353 NUCLEAR DEFORMATIONS IN THE PAIRING-PLUS-QUADRUPOLE MODEL. IV. THEORY OF COLLECTIVE MOTION. Baranger, Michel (Carnegie-Mellon Univ., Pittsburgh); Kumar, Krishna. Contract AT(11-1)-1051. Nucl. Phys., A122: 241-72(1968).

A theory of collective motion based on the time-dependent Hartree–Bogolyubov approximation is shown to be possible for the pairing-plus-quadrupole model. It is a non-linear adiabatic theory, which makes it suitable for soft nuclei. The results are very close to those of the cranking theory, but they are not subject to the objections usually made against the latter. Explicit formulas are given for the potential energy, the three moments of inertia and the three vibrational inertial parameters entering Bohr's collective Hamiltonian for arbitrary quadrupole deformations and for the gyromagnetic ratios. A simple extension of the theory is found able to deal with core polarization. The theory has no obvious generalization to two-body forces other than pairing-plus-quadrupole. (auth)

7354 PROPERTIES OF THE KERNEL OF A THREE-BODY LIPPMANN–SCHWINGER EQUATION. Gloeckle, W.; Heiss, W. D. (Univ., Heidelberg). Nucl. Phys., A122: 343-52(1968).

The kernel $K = (W - T_1 - T_2 - V_1 - V_2)^{-1}V_{12}$ is investigated, where V_1 and V_2 are single-particle potentials and V_{12} a two-body interaction. Thereby a partial-wave decomposition is introduced which defines radial kernels. Their singularities in W are elaborated. Further it is proved that each of these radial kernels is of the Hilbert–Schmidt type in contrast to the full kernel K. (auth)

7355 INDEPENDENT-PAIR WAVE FUNCTIONS FOR THE THREE- AND FOUR-BODY NUCLEI. Folk, R. T. (Lehigh Univ., Bethlehem, Pa.). Nucl. Phys., A122: 353-72(1968).

A method which was described previously for generating independent-pair wave functions for three-nucleon systems is generalized so that the S' state with mixed symmetry can be included in three-body calculations and so that the method can be used to generate independent-pair wave functions for the alpha particle. This procedure is used to find approximate ground-state functions for several three- and four-body Hamiltonians. The functions so obtained are used to calculate an upper and, in some cases, a

lower bound to the ground-state energy and to calculate the charge form factors for these three- and four-body systems. When the interactions are chosen so that both low- and high-energy two-nucleon data are correctly predicted, then the calculated binding energies are slightly too large, the ratio of the form factors for ^{3}H to that of ^{3}He is consistent with the experimental ratio, and the form factors for all three nuclei are too large at large momentum transfers. By increasing the radius of the hard core, the calculated form factor functions are decreased closer to the experimental ones. (auth)

7356 ON THE PROBLEM OF UNRESOLVED RESONANCES IN NEUTRON SPECTROSCOPY. Musgrove, A. R. de L. (Australian Atomic Energy Commission, Sutherland). Aust. J. Phys., 21: 779-92(Dec. 1968).

A direct method of calculating the probability for missing levels in slow neutron spectroscopy is described. The method gives a criterion for missing levels based on the Breit–Wigner resonance profile between adjacent levels and does not depend on correcting an observed distribution of resonance parameters to the theoretically expected distribution. (auth)

7357 METHOD FOR DETERMINING TOTAL PROTON REACTION CROSS SECTIONS. Hojvat, Carlos Federico. Vancouver, B. C., Univ. of British Columbia, 1967. Thesis.

Measurements of total proton reaction cross sections by the beam-attenuation method involve determinations of the number of protons removed from the incident beam by an absorber compared to those transmitted. This work presents an adaptation of the associated-particle technique to enable total reaction cross section measurements for the 15.8-MeV protons from the ^{3}He(d,p)^{4}He reaction. A thick heavy ice target is bombarded with 600-keV ^{3}He particles. The ^{4}He particles are detected in a silicon surface-barrier detector, and the protons, after traversing the absorber, in a CsI scintillation counter. Both the spatial collimation and the time of arrival of the proton are defined by the detection of the associated ^{4}He particle. Thus, removal of a proton from the proton "beam" is identified by an anticoincidence between the ^{4}He and proton counters, whereas proton transmission is identified by a coincidence. The limitations and applications of the technique are presented, as well as a discussion of the critical portions of the experimental design. (Diss. Abstr.)

7358 COLLECTIVE EFFECTS AT NEUTRON INELASTIC SCATTERING BY EVEN–EVEN NUCLEI. Konstantinov, B. D.; Korolev, A. M. (Kiev Inst. of Physics). Ukr. Fiz. Zh., 13: 1693-1700(Oct. 1968). (In Russian).

By means of the Green function method, the problem of neutron inelastic scattering by spherical even–even nuclei is considered. The assumption is made that in this case only collective freedom degrees can be excited corresponding to the nucleus surface oscillations, but excitation of one-particle levels and the process penetration through a compound nucleus are hardly probable. The Bohr collective vibrational model is used to describe collective excitations of a nucleus surface which are formed at the neutron–nucleus interaction. To solve this problem, a technique is suggested which enables one to take into account exactly an unlimited number of excitation phonons. General expressions are obtained for differential and total effective inelastic cross sections at excitation of N-phonon level of the nucleus with the moment L, as well as a comparatively simple expression for scattered-particle amplitudes at excitation of one-phonon and two-phonon nucleus levels. (auth)

7359 11-MeV PROTON OPTICAL-MODEL ANALYSIS. Perey, C. M. (Oak Ridge National Lab., Tenn.); Perey, F. G.; Dickens, J. K.; Silva, R. J. Phys. Rev., 175: 1460-75(Nov. 20, 1968).

An optical-model analysis of elastic scattering of 11-MeV protons from 24 nuclei in the mass range ^{45}Sc to ^{76}Ge is presented. The data analyzed include 18 angular distributions which we have measured and the previously published 10.5-MeV elastic-polarization data. An average set of geometrical parameters is determined for the data, and the real radius parameter of this potential is substantially larger than normally used at higher energies. The analysis performed with a fixed geometry, but allowing the well depths to be readjusted independently for each nucleus, reveals a very smooth dependence of the real-well depth as a function of mass number. However, the real-well depths fail to follow the expected isospin dependence of the optical potential. (auth)

7360 "SHELLS" IN DEFORMED NUCLEI. Strutinskii, V. M. (Kurchatov Inst. of Atomic Energy, Moscow. Univ. of Copenhagen). Nucl. Phys., A122: 1-33(1968).

New calculation results based on the shell correction method are described. The results are presented in such a way as to illustrate more clearly many effects of nucleon shells in deformed and spherical nuclei. Some complementary theoretical arguments related to the shell correction method and details of the calculation are given. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

7361 (AEC-tr-6957) SIEMENS AND NUCLEAR POWER STATIONS WITH PRESSURIZED WATER REACTORS. Translation of a German report. 78p. Dep. CFSTI.

The reactor technology developed and used by the German firm of Siemens is detailed. Development of pressurised water reactors is discussed. A complete description of the Stade Power Reactor is given; descriptions of all core, containment, safety, and auxiliary systems are included. Design parameters for the Stade Power Reactor are tabulated; engineering drawings are included. (M.L.S.)

7362 (APDA-NTS-20) TRANSIENT EFFECTS OF LOSS OF ONE COOLANT CIRCUIT ON THE ENRICO FERMI REACTOR AND ASSOCIATED HEAT TRANSPORT SYSTEM. Ziniuk, M. A.; Wilber, H. A. (Atomic Power Development Associates, Inc., Detroit, Mich.). Sept. 1968. 35p.

Results obtained from a single-circuit shutdown test performed on the Enrico Fermi reactor at a thermal power level of 20 MW are presented. The test, commencing with deactivation of one coolant circuit during three-circuit operation, was conducted to ascertain the transients in the principal plant parameters, to observe plant stabilization characteristics, and to verify system controls and interlocks. Recordings obtained in the test have provided values for the negative rate-of-change of reactor power, steady-state power level, rates-of-change of the principal temperature parameters, and the transport lags of the responses. (auth)

7363 (APDA-NTS-21) SETBACK TESTS TO DETERMINE THERMAL TRANSIENTS AND CONTROL PERFORMANCE: ENRICO FERMI REACTOR. Ziniuk, M. A.; Wilber, H. A. (Atomic Power Development Associates, Inc., Detroit, Mich.). Nov. 1968. 33p.

Results of setback tests conducted on the Enrico Fermi reactor at thermal power levels of 50 and 75 MW are presented. Setbacks at each power level were initiated manually, and by temperature and power, to determine thermal transients, setback system operation, and performance of reactor controls. Recordings obtained in the tests have furnished values of the thermal transients and the magnitude of the power of the setbacks for conditions of the test. Satisfactory control of the reactor in setback was verified. (auth)

7364 (DOCKET-50245-6) MILLSTONE NUCLEAR POWER STATION, UNIT 1. [Final Safety Analysis Report], Amendment 9. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). Nov. 4, 1968. 80p. Dep. CFSTI.

A comparison of the Millstone Point Power Reactor, Unit 1 with the 70 General Design Criteria is given. The quality assurance program is outlined. ASME Class A vessels are tabulated; stub tube stress evaluations are given; stainless steel materials used in the pressure vessel are tabulated. Emergency Core Cooling Systems (ECCS) design criteria are given; flooding from an ECCS pipe leak is considered. Containment heat exchanger capacity is evaluated. Operational procedures, inspections, and quality control problems are discussed. A summary evaluation of the containment vessel insert plate welds is included. (M.L.S.)

7365 (DOCKET-50285-15) FORT CALHOUN STATION, UNIT NO. 1. Facility Description and Safety Analysis Report, Vol. 1, Exhibit F. (Omaha Public Power District, Nebr.). Apr. 18, 1967. 392p. Dep. CFSTI.

Information on Fort Calhoun Power Reactor Unit 1 is given under the following broad topics: Introduction and Summary; Site and Environment; Reactor; Reactor Coolant System; Containment System; and Engineered Safeguards. (D.C.C.)

7366 (DOCKET-50285-16) FORT CALHOUN STATION, UNIT NO. 1. Facility Description and Safety Analysis Report, Vol. 2, Exhibit F. (Omaha Public Power District, Nebr.). Apr. 18, 1967. 298p. Dep. CFSTI.

Information on Fort Calhoun Power Reactor Unit 1 is given under the following broad topics: Instrumentation and Controls; Electrical Systems; Auxiliary Systems; Steam and Power Conversion Systems; Radioactive Waste Disposal and Control Systems; Radiation Protection and Monitoring; Design Standards of Structures other than Containment; Pre-operational Test Programs and Conduct of Operations; Safety Analysis of Core and Coolant Boundary Protection; and Safety Analysis of Standby Safeguards. Appendices contain information on site environmental studies. (D.C.C.)

7367 (DOCKET-50286-9) INDIAN POINT NUCLEAR GENERATING, UNIT NO. 3. Preliminary Safety Analysis Report, Amendment 6, Suppl. 6, Exhibit B-6. (Consolidated Edison Co. of New York, Inc., New York). Nov. 25, 1968. 34p. Dep. CFSTI.

Revised information is given on the Indian Point Power Reactor, Unit 3 under the following broad topics: instrumentation, electrical power supplies, fuel and fuel clad performance, and rod drop accident analysis. (D.C.C.)

7368 (DOCKET-50312-7) RANCHO SECO NUCLEAR GENERATING STATION, UNIT NO. 1. ACRS Report. (Atomic Energy Commission, Washington, D. C. Advisory Committee on Reactor Safeguards). July 19, 1968. 3p. Dep. CFSTI.

The complete ACRS report on Rancho Seco Power Reactor, Unit 1 is included. (M.L.S.)

7369 (DOCKET-50317-7) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 4. (Baltimore Gas Electric Co., Md.). Nov. 7, 1968. 445p. (DOCKET-50318-7). Dep. CFSTI.

Information on the soil foundation for the siting of the Calvert Cliffs Power Reactor Unit 1 and Unit 2 is presented. The effects of wind speed on dilution factors are determined. Development of the fuel assembly is described. Hydraulic characteristics of the reactor are analyzed. Moderator temperature coefficients are calculated. Control rod position monitoring is discussed. Thermal shock analysis for reactor emergency core cooling is presented. Containment structure loadings due to tornado forces are calculated. Discontinuity stresses in the base, dome, and buttresses are analyzed. Joints and seals for the prestressed containment structure and auxiliary buildings are described. Anchorage and stress distribution in the prestressed concrete containment structure are determined. Containment structure penetrations are described and effects on containment structure stress distribution is determined. Construction procedures are described. The emergency core cooling system is described. The containment spray system is described. Personnel requirements are listed. Prefueling tests are outlined. Pages of revised information are included. (D.C.C.)

7370 (DOCKET-50320-8) OYSTER CREEK NUCLEAR STATION, UNIT 2. Preliminary Safety Analysis Report, Amendment 5. (Jersey Central Power and Light Co., Morristown, N. J.). Nov. 29, 1968. 255p. Dep. CFSTI.

Seismic design criteria for Oyster Creek Power Reactor, Unit 2, are given. An analysis of loss-of-coolant accidents and seismic loadings on cooling system components is detailed. Changes in engineered safety features are outlined. Intermediate cooling system and decay heat removal system equipment is tabulated. Tornado-generated external missile protection is discussed. Containment structural design is detailed; testing and surveillance programs for the containment buildings are described. Effects of operation of the ECCS on core internals are analyzed; efficiency of sodium thiosulfate as a containment spray is discussed. Required loads on the emergency diesel during loss of offsite power are tabulated. The use of partial length control rods for control of axial xenon oscillations is discussed. Calculation of pressure vessel nvt is discussed. Research and development areas are identified; each area is discussed briefly. Waste handling and discharge is discussed. Iodine losses following coolant loss accidents are analyzed; safety aspects are discussed. (M.L.S.)

7371 (NP-17703) ATOMIC POWER AND OIL INDUSTRY. Matsune, Soichi; Sakisaka, Masao (Japan Atomic Industrial Forum, Inc., Tokyo). Mar. 1968. 19p. Dep.

The effects of nuclear power development on the heavy oil industry are discussed. Economic predictions to 1985 are presented for supply-and-demand comparisons of heavy oil and nuclear power. The relationship between the demand for heavy oil and yield ratio of gasoline and naphtha is predicted to 1995. (D.C.C.)

7372 METHOD OF AND COMPOSITION FOR DECONTAMINATING NUCLEAR REACTORS. (to United States Atomic Energy Commission). British Patent 1,130,068. Oct. 9, 1968. Priority date Apr. 28, 1966, United States.

A method of decontaminating a nuclear reactor cooling system composed primarily of stainless steel, subjected to extended circulation of hot water during reactor operation, comprises circulating through the system a hot alkaline, aqueous, $KMnO_4$ solu-

tion followed by a solution of the following composition: oxalic acid, 20 to 30 g/l; dibasic ammonium citrate, 40 to 60 g/l; ferric sulfate or nitrate, 1.7 to 2.4 g/l; diethylthiourea, 0.8 to 1.2 g/l. (B.L.M.)

7373 PROCEEDINGS OF THE 1967 CONFERENCE, ATOMIC INDUSTRIAL FORUM, INC., CHICAGO, ILLINOIS, NOVEMBER 6–9, 1967. AtomForum 1967. New York, Atomic Industrial Forum, Inc., 1968. 311p. $15.00. (CONF-671115).

Panel discussions and questions are presented on the following broad topics: The Uranium Situation; Commercial Prospects and Plans; Prospects for International Arms Control and Inspection; Operating Experience with Power Reactors; A Positive Approach to Competition in the Nuclear Industry; Informing the Public; Space and Marine Applications; Government's Changing Role in Atomic Energy; Reactor Safety and Licensing; and Nuclear Energy and the Electric Power Industry. Individual abstracts are prepared for each of the sessions. (M.L.S.)

For abstracts of individual sections see: 6281, 7374–7379, 7384, 7411, and 7434.

7374 NUCLEAR ENERGY AND THE ELECTRIC POWER INDUSTRY. Ward, J. Harris (Commonwealth Edison Co., Chicago). pp 295-303 of Proceedings of the 1967 Conference, Atomic Industrial Forum, Inc., Chicago, November 6–9, 1967. New York, Atomic Industrial Forum, Inc., 1968.
See CONF-671115.

The effects of nuclear energy on the electric power industry are discussed. The position of the nuclear industry within the industrial structure is considered; regulatory, research, and management phases of nuclear energy are discussed with respect to electricity production. (M.L.S.)

7375 REACTOR SAFETY AND LICENSING. pp 255-93 of Proceedings of the 1967 Conference, Atomic Industrial Forum, Inc., Chicago, November 6–9, 1967. New York, Atomic Industrial Forum, Inc., 1968.
See CONF-671115.

Detailed analyses of power reactor licensing procedures are given; viewpoints of representatives of the nuclear industry and the USAEC regulatory groups are presented. The function and utility of the ACRS are considered. Periods required for issuance of AEC construction permits are evaluated; economic impact of regulatory review is considered. The discussions are presented by a panel composed of: Harvey Brush, Chairman; Robert D. Allen, Gerald Charnoff, David J. Fogarty, Robert Lowenstein, Peter A. Morris, Theodore Rockwell III, Robert E. Wachser, and John M. West. (M.L.S.)

7376 GOVERNMENT'S CHANGING ROLE IN ATOMIC ENERGY. pp 215-49 of Proceedings of the 1967 Conference, Atomic Industrial Forum, Inc., Chicago, November 6–9, 1967. New York, Atomic Industrial Forum, Inc., 1968.
See CONF-671115.

A historical account of the development of atomic energy is given. The roles of the AEC and the national labs are discussed; the idea of use of the national labs as a national resource is proposed. The roles of state and international agencies in the future development of nuclear energy are considered. The past, present, and predicted future of Plowshare projects are summarized. Questions on nuclear power plant licensing difficulties are considered; thermal effects and thermal enrichment are discussed in relation to economics, aesthetics, and jurisdiction. (M.L.S.)

7377 INFORMING THE PUBLIC. pp 153-73 of Proceedings of the 1967 Conference, Atomic Industrial Forum, Inc., Chicago, November 6–9, 1967. New York, Atomic Industrial Forum, Inc., 1968.
See CONF-671115.

The role of the information center in the public acceptance of nuclear power is discussed; capital and operating costs are given; subject emphasis is outlined. A summary of USAEC public information activities related to the nuclear industry is given. The relation of the nuclear power plant to the environment and environmental quality is discussed. (M.L.S.)

7378 A POSITIVE APPROACH TO COMPETITION IN THE NUCLEAR INDUSTRY. Ramey, James T. (Atomic Energy Commission, Washington, D. C.). pp 135-51 of Proceedings of the 1967 Conference, Atomic Industrial Forum, Inc., Chicago, November 6–9, 1967. New York, Atomic Industrial Forum, Inc., 1968.
See CONF-671115.

The role of the USAEC in fostering competition in the nuclear industry is discussed. The 1967 orders for nuclear steam supply systems are tabulated. Future development of light water and breeder reactors is discussed. General AEC policy is outlined with respect to the roles of industry and government. 19 references. (auth)

7379 OPERATING EXPERIENCE WITH POWER REACTORS. pp 97-133 of Proceedings of the 1967 Conference, Atomic Industrial Forum, Inc., Chicago, November 6–9, 1967. New York, Atomic Industrial Forum, Inc., 1968.
See CONF-671115.

Operating experience is summarized for: Peach Bottom Power Reactor, Unit 1, EBR-2, Yankee Power Reactor, and Dresden Power Reactor, Unit 1. A panel discussion of operating experience with power reactors is included. (M.L.S.)

7380 IN-CORE VIEWING AND REMOTE HANDLING PROBLEMS OF GAS-COOLED REACTORS. Weaving, A. H.; Carver, J. A.; Varney, E. J. (Central Electricity Generating Board, [London]). J. Brit. Nucl. Energy Soc., 7: 343-52(Oct. 1968).

Occasional equipment failures occur inside gas-cooled reactors, necessitating an internal inspection and possibly a recovery operation. Physical entry into the reactor is extremely difficult and remote handling and viewing equipment has been developed. Television cameras are available for inspection and recovery operations in fuel channels. Flash photography has been used extensively in-pile, and special cameras have been developed for this purpose. The requirements for such equipment are discussed, together with a number of recovery operations undertaken at different nuclear power stations. (auth)

Power Reactor Development

7381 (APDA–232) QUARTERLY TECHNICAL PROGRESS REPORT ON AEC-SPONSORED ACTIVITIES, JULY–SEPTEMBER 1968. (Atomic Power Development Associates, Inc., Detroit, Mich.). Contract AT(11-1)-865. 28p. Dep. CFSTI.

CROLOY — wastage effects of sodium-water reaction on tubes of
FERMI FAST BREEDER REACTOR — operating experience compilation for, status of
INCOLOY 800 — wastage effects of sodium-water reaction on tubes of
OXYGEN — determination in sodium, evaluation of Rhometer for
SODIUM — reaction with water, wastage effects on steam generator tubes of
— oxygen determination in, evaluation of Rhometer for
STAINLESS STEEL — wastage effects of sodium-water reaction on tubes of (H.D.R.)

7382 (BNWL–516) THERMOS/BATTELLE: THE BATTELLE VERSION OF THE THERMOS CODE. Skeen, D. R.; Page, L. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1967. Contract AT(45-1)-1830. 94p. Dep. CFSTI.

The many revisions made to the THERMOS program are combined to form a new program, THERMOS/BATTELLE. The program input is listed and the program output is described. (D.C.C.)

7383 NUCLEAR ENERGY. Wirtz, K. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Therapiewoche, 17: 2047-55(Dec. 13, 1967). (In German).

The principles of energy production in nuclear reactors are summarized. The problems in the construction of an economical power reactor are indicated. The principal reactor types are described and illustrated. The German nuclear energy program, based on the two-type strategy of water reactors up until 1980 with a shift then to fast breeders to be completed by 1990, is discussed briefly. (J.S.R.)

7384 NUCLEAR INDUSTRY IN 1967 AND ITS FUTURE PROSPECTS. Tremmel, Ernest B. (Atomic Energy Commission, Washington, D. C.). pp 47-57 of Proceedings of the 1967 Conference, Atomic Industrial Forum, Inc., Chicago, November 6–9, 1967. New York, Atomic Industrial Forum, Inc., 1968.
See CONF-671115.

The 1967 status of the Nuclear Industry is summarized; highlights of the year are reviewed. Commercial food irradiation is discussed. The economics of ^{60}Co production in commercial power reactors is considered. (M.L.S.)

Kinetics and Dynamics

7385 (ANL-7414) IN-CORE ACTIVATION TRAVERSES DURING THE PLUTONIUM RECYCLE EXPERIMENT IN THE EXPERIMENTAL BOILING WATER REACTOR AT POWER LEVELS OF 35 TO 70 MW. Grajek, R. E.; Freese, K. E. (Argonne National Lab., Ill.). July 1968. Contract W-31-109-eng-38. 24p. Dep. CFSTI.

In-core activation traverses during the Plutonium Recycle Experiment in the Experimental Boiling Water Reactor are described. Traverses were made with bare and Cd-covered Al–Mn spheres and also Cu, Au, Ir, and Lu. Power levels of 37, 40, 61, and 70 MW were held during the measurements. Thermal neutron flux distributions are included. (D.C.C.)

7386 (EURFNR-496) ANALOG COMPUTATION MODEL FOR STEAM-COOLED DIRECT-CYCLE FAST REACTORS. Frisch, W.; Wolte, G. (Kernforschungszentrum, Karlsruhe (West Germany)). Translated from report KFK-657. 60p. (EUR-3693). Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

An analog computer model is described which was developed to study the dynamics of the D1 steam-cooled fast breeder reactor. The model can also be used to study steam-cooled direct-cycle reactors (Loeffler principle or injection steam generator), allowing for the existence of several parallel cycles in the plant. The program simulates dynamic behavior in normal operating conditions and in perturbation conditions. Reactor power, reactivity, fuel temperature, cladding and coolant, and mass flow and pressures are represented as a function of time. (D.C.C.)

Shielding

7387 (GA-8776) EFFECTS OF TEMPERATURE ON A PRESTRESSED CONCRETE REACTOR VESSEL MODEL. Northup, T. E.; Ople, F. S. Jr. (Gulf General Atomic, Inc., San Diego, Calif.). Aug. 1, 1968. Contract AT(04-3)-633. 28p. (CONF-681109-1). Dep. CFSTI.

From Symposium on the Effect of Temperature on Concrete, Memphis, Tenn.

Results of elevated temperature tests on a one-quarter scale prestressed concrete reactor vessel (PCRV) model are reported. The long-term behavior of the PCRV model was evaluated for sustained temperatures up to 140°F (60°C). Major emphasis was placed on the creep of concrete subjected to complex mechanical and thermal loading conditions. The effect of elevated temperature on the creep (including shrinkage) of concrete in a PCRV model was observed to be less severe than the effect that normally would be observed in tests on small plain concrete specimens. Approximations utilizing uniaxial creep data can lead to substantial overestimation of concrete creep deformations in a complex structure, especially at elevated temperatures. The approach using viscoelastic finite-element analysis along with similar uniaxial creep data is shown to produce better prediction of concrete creep behavior in a PCRV model. (auth)

Cooling Systems

7388 STUDIES ON CATALYTIC RECOMBINER FOR BOILING WATER REACTORS. III. ANALYSIS OF REACTION PROCESS CALCULATIONS. Murata, Toshifumi; Yusa, Hideo (Hitachi, Ltd., Tokyo). Nippon Genshiryoku Gakkaishi, 10: 626-31 (Nov. 1968). (In Japanese).

Experiments were performed with a 10 cm diameter, 8 cm deep bed of Pd catalyst supported on Al_2O_3, under the conditions of 130°C inlet temperature and $5 \times 10^2 \sim 1.5 \times 10^3$ kg/m^2·hr mass velocity of gas, which included steam, air, and H_2. The results obtained for temperature distribution in the bed and for hydrogen concentration in the effluent agreed closely with the calculations. (auth)

Fuels

Refer also to abstract 6724.

7389 (GA-7645) GAS-COOLED FAST BREEDER REACTOR. Annual Progress Report for the Period Ending July 31, 1966. (Gulf General Atomic, Inc., San Diego, Calif.). May 31, 1968. Contract AT(04-3)-167. 292p. Dep. CFSTI.

ALUMEL COUPLES—alumel/chromel, performance of, measurement of 0 to 800°C output
—alumel/Hastelloy X, performance of thermocouples of, measurement of 0 to 800°C output
CHROMEL COUPLES—alumel/chromel, performance of, measurement of 0 to 800°C output
—chromel/Type 304 stainless steel, performance of thermocouples of, measurement of 0 to 800°C output
CRITICALITY STUDIES—measurement of plutonium oxide (PuO_2)–polystyrene (C_8H_8), effects of density and configuration on
HASTELLOY X—alumel/Hastelloy X, performance of thermocouples of, measurement of 0 to 800°C output
—cladding for 1000 MW(e) gas-cooled fast breeder reactor pellet-type uranium oxide (UO_2) fuel element, fabrication and irradiation testing of
NEUTRONS, THERMAL—effects on 1000 MW(e) gas-cooled fast breeder reactor Hastelloy X-clad uranium oxide (UO_2) pellet-type fuel elements
PLUTONIUM OXIDES PuO_2—CsHS–PuO_2, criticality of, effects of density and configuration on
REACTOR FUEL ELEMENTS—fabrication of 1000 MW(e) gas-cooled fast breeder reactor Hastelloy X-clad uranium oxide (UO_2) pellet-type, description of
—radiation effects on 1000 MW(e) gas-cooled fast breeder reactor Hastelloy X-clad uranium oxide (UO_2) pellet-type, thermal neutron
REACTORS, BREEDER—fuel element for 1000 MW(e) gas-cooled fast, fabrication and irradiation testing of Hastelloy X-clad uranium oxide (UO_2) pellet-type
REACTORS, FAST—fuel element for 1000 MW(e) gas-cooled breeder, fabrication and irradiation testing of Hastelloy X-clad uranium oxide (UO_2) pellet-type
REACTORS, GAS-COOLED—fuel element for 1000 MW(e) fast breeder, fabrication and irradiation testing of Hastelloy X-clad uranium oxide (UO_2) pellet-type
REACTORS, POWER—fuel element for 1000 MW(e) gas-cooled fast breeder, fabrication and irradiation testing of Hastelloy X-clad uranium oxide (UO_2) pellet-type
SODIUM HYDROXIDES—corrosive effects of, analysis of temperature and concentration variations on
STAINLESS STEEL—chromel/Type 304 stainless steel, performance of thermocouples of, measurement of 0 to 800°C output
STAINLESS STEEL—corrosion by sodium hydroxide (NaOH) of, effects of temperature and concentration on
STYRENE POLYMERS—CsHS–PuO_2, criticality of, effects of density and configuration on
URANIUM OXIDES UO_2—fuel for 1000 MW(e) gas-cooled fast breeder reactor, fabrication and irradiation testing of Hastelloy X-clad pellet-type (D.L.C.)

7390 HEAT TRANSFER IN A FLUID WITH INTERNAL HEAT GENERATION FLOWING THROUGH A VERTICAL TUBE. Michiyoshi, Itaru; Kikuchi, Yoshihiro; Furukawa, Osamu (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo), 5: 590-5(Nov. 1968).

Heat transfer in a fluid, with uniformly distributed internal heat source, flowing upwards through a vertical tube is analyzed. Measurements were made of the temperature distribution in both laminar and turbulent flow, and both with and without heat transfer at wall. Heat generation within the fluid was brought about by passing an electrical current through the working fluid, which was an aqueous solution of sodium chloride. The experimental results were compared with analytical calculations. Free convection, which occurs and is superimposed on the movement by forced convection, flattens the fluid temperature distribution in laminar flow through thermally insulated vertical tube. In turbulent flow with heat transfer to wall, the temperature distribution near the wall is affected considerably by the outgoing heat flux. (auth)

7391 FURTHER REACTOR PHYSICS STUDIES FOR STEAM GENERATING HEAVY WATER REACTORS. PART 3. COOLANT TEMPERATURE EFFECTS IN UO_2 AND PuO_2/UO_2 FUELS. Briggs, A. J.; Johnstone, I.; Newmarch, D. A.; Kemshell, P. B. (United Kingdom Atomic Energy Establishment, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 7: 353-65(Oct. 1968).

Previous measurements of a range of detailed reaction rates in SGHW lattices at ambient temperature were extended to cover coolant temperatures up to 274°C. The measurements were made in a single-channel, hot pressurized loop in the zero energy reactor JUNO, and included the study of UO_2 fuel and of PuO_2-UO_2 fuel containing 8 kg/te Pu with 24% ^{240}Pu. In each case the heated channel was surrounded by 36 channels of similar cold fuel. The measurements showed that the small discrepancies observed between measured cluster mean reaction rates and the METHUSELAH II and WIMS predictions are not significantly increased by the rise in temperature. The total reactivity effects of these discrepancies are less than 0.5% for both methods of calculation and lie within the experimental uncertainties. The use of transport theory, and the better spectrum models available in WIMS, lead to improved predictions of cluster distributions of spectrum sensitive reaction rates in the hot condition. (auth)

Auxiliary and Emergency Systems

Refer to abstracts 6245 and 6320.

Safety and Siting

7392 EFFECT OF CORE SPRAY COOLING IN TRANSIENT STATE AFTER LOSS OF COOLANT ACCIDENT. Yamanouchi, Atsuo (Hitachi, Ltd., Japan). J. Nucl. Sci. Technol. (Tokyo), 5: 547-58(Nov. 1968).

To examine the conditions brought about upon initiation of core spraying, a 36-rod assembly was heated to different temperatures and then spray cooled. The runs were made at atmospheric pressure using two kinds of assemblies, both made up of heater rods of 15 mm outer sheath diameter, arrayed into 6 × 6 lattice accommodated in a 119 × 119 mm^2 channel, but with heated lengths of 1,500 and 2,500 mm. Results are described. (auth)

Research and Test Reactors

7393 (BAW-3968-1) EXAMINATION OF FAST REACTOR FUELS. Final Technical Report, April–June 1968. Schmitt, D. H. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Aug. 1968. Contracts AT(30-1)-3968; 859-3106. 120p. Dep. CFSTI.

In order to determine the capabilities of the Babcock & Wilcox analytical laboratory to characterize FFTF fuels, sintered PuO_2-UO_2 pellets were obtained from the Pacific Northwest Laboratory (PNL). This characterization required the development and standardization of several analytical methods. Results were obtained for the following measurements: assay for uranium and plutonium; isotopic assay; gas evolution; density; and homogeneity and solid solution. (auth)

7394 (BNL-13001) SAFETY REVIEW OF THE BROOKHAVEN CHEMONUCLEAR IN-PILE RESEARCH LOOP. Steinberg, M.; Tucker, W.; Waide, C.; Beller, M.; Bezler, P.; Manowitz, B. (Brookhaven National Lab., Upton, N. Y.). Oct. 1968. 72p. Dep. CFSTI.

The Chemonuclear In-Pile Research Loop installed in the Brookhaven Graphite Research Reactor is a facility for investigating chemonuclear reactions under flow conditions. It is designed to handle gaseous systems in conjunction with packages of solid fixed fuel. The facility design, operation and research program, and hazards analysis are described. (H.D.R.)

7395 (BNWL-883) HYDRAULIC BALANCE CONCEPT AND TUBESHEET LEAKAGE FFTF HYDRAULIC FEATURE MODEL. Jackson, P. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1968. Contract AT(45-1)-1830. 78p. Dep. CFSTI.

Evaluations of the inlet plenum hydraulic balance concept and leakage rates resulting from various tube-to-tubesheet configurations are presented. Test apparatus and experimental results are presented. (D.C.C.)

7396 (BNWL-CC-604) DETERMINATION OF OXIDE FUEL TEMPERATURE PROFILES. Christensen, J. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1, 1966. Contract AT(45-1)-1830. 11p. Dep. CFSTI.

Data for peak fuel heat ratings for the PRTR short core are presented. Data for UO_2 powder and pellet and PuO_2-UO_2 are presented. (D.C.C.)

7397 (BNWL-SA-1826) FAST FLUX TEST FACILITY INSTRUMENTATION REQUIREMENTS. Swanson, C. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1968. Contract AT(45-1)-1830. 54p. (CONF-681017-6). Dep. CFSTI.

From 15th Nuclear Science Symposium, Montreal, Canada.

The Fast Flux Test Facility (FFTF) is the major irradiation test facility planned for the Liquid Metal Fast Breeder Reactor (LMFBR) Program. The facility instrumentation requirements, with particular emphasis on out-of-core instrumentation, are discussed. In-core instrumentation requirements are described in more general terms due to their greater dependence on reactor concept decisions. Out-of-reactor instrumentation requirements included in these discussions are: sodium and inert gas purity, sodium heat transport system measurements, fuel handling and examination, radiation monitoring, containment actuation and process control problem areas. Considerations leading to provisions for a multiple digital computer-based data handling and display system are described. (auth)

7398 (BNWL-SA-2168) RADIOISOTOPE TRANSPORT AND DEPOSITION IN FLOWING SODIUM. Brehm, W. F.; Kovacevich, E. A.; Shannon, D. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 22, 1968. Contract AT(45-1)-1830. 15p. (CONF-681106-2). Dep. CFSTI.

From Conference on Sodium Technology and Large Fast Reactor Design, Argonne, Ill.

Transport and deposition of radioisotopes released to flowing sodium from corrosion of irradiated stainless steel are studied. Quantitative measurements of deposition can be made with sensitive counting techniques. The results indicate that ^{51}Cr and ^{60}Co are transported primarily by isotopic exchange, and do not rapidly migrate to lower temperature regions of loop systems. However, ^{54}Mn is released in larger quantities to deposit throughout the test loops. Preferential deposition sites are immediately downstream from the source, at minimum temperature locations, and in oxygen cold traps. These results indicate that ^{54}Mn is transported both by exchange and by solution-and-precipitation. Deposited ^{54}Mn migrated rapidly to the cold trap, deposited ^{51}Cr and ^{60}Co migrated slowly by exchange. (auth)

7399 (GEAP-5673) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR DEVELOPMENT PROGRAM. Seventeenth Quarterly Report, May–July 1968. Pflasterer, G. R. (comp.) (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Aug. 1968. Contract AT(04-3)-540. 31p. Dep. CFSTI.

Topics discussed include: core flux detector system; fast reactivity excursion device (FRED); fabrication of fuel pellets of UO_2 and PuO_2-UO_2; startup testing; transient tests; and SEFOR operations and construction. (D.C.C.)

7400 (IDO-17279) SPERT PROJECT. Quarterly Technical Report, October–December 1967. Taxelius, T. G. (ed.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Oct. 1968. Contract AT(10-1)-205. 24p. Dep. CFSTI.

REACTOR SAFETY EXPERIMENTS—transient testing of oxide E-core in Spert III at elevated initial power
—neutron detector calibration constants for Spert III from flux wire activation data
—cooling system heat balance power calibration in Spert III high-power transient testing
—fuel rod performance in Spert IV Capsule Driver Core, failure testing of F-type
REACTOR FUEL ELEMENTS—failure testing of Spert IV dry and waterlogged F-type
—failure of Spert IV F-type, fuel particle size distribution from
REACTIVITY—insertion effects on Spert III peak power during high-power transient testing (H.D.R.)

7401 (IS-1917) COMBINED CRYOSTAT-FLUX CONVERTER SYSTEM FOR REACTOR IRRADIATIONS IN LIQUID NITROGEN. Chen, C. W.; Struss, R. G. (Ames Lab., Iowa). Aug. 1968. Contract W-7405-eng-82. 25p. Dep. CFSTI.

A combined system of a cryostat and a flux converter was installed in one of the side vertical thimbles of the Ames Laboratory Research Reactor. The cryostat operates on the thermosiphon principle and allows the irradiation experiments to be performed at temperatures between 80 and 870°K. In addition to varying and controlling the temperature of irradiation over such a wide range, the cryostat also makes it possible to conduct in-pile experimentation within the cylindrical dewar tube of 2.54-cm diameter. The flux converter, which lies peripherally around the bottom section of the dewar vessel of the cryostat, is constructed of CP-5 type fuel tubes from Argonne National Laboratory. Measurements of neutron flux conducted inside the dewar vessel indicate that the converter is capable of providing a constant fast neutron flux of $(3-4) \times 10^{12}$ n/cm^2/sec (E > 1 MeV) in the lower 30.5-cm section of the dewar vessel. The main design features and the performance characteristics of the combined system are described along with the conditions required for a safe and steady operation of the cryostat. (auth)

7402 (KFK-818) SAFETY REPORT ON THE COLD NEUTRON SOURCE AT FR2, PROJECT FR2/16. Spath, F.; Karb, E.; Oehme, H. (Kernforschungszentrum, Karlsruhe (West Germany)). Jan. 1968. 90p. (In German). Dep.

Various physical experiments require the highest possible flux of sub-thermal neutrons. In order to permit such studies, a cold neutron source will be installed in the horizontal hole R3 of the reactor FR2. This source mainly consists of a moderator chamber to be placed into the reactor reflector zone. It is filled with some 220 cm^3 of liquid H_2 and cooled by gaseous He in a He refrigeration system equipped with expansion turbines. An apparatus containing 1 standard m^3 of gaseous H_2 feeds the chamber, and a vacuum system provides the refrigeration isolation. The background of higher-energetic neutrons is reduced by a neutron filter made of Be which is mounted in the beam tube and cooled with liquid N_2. In order to avoid a reaction between H_2 and air as well as other conceivable hazards, a number of safety precautions were taken; besides, the H_2 chamber was surrounded by a pressure tube to protect the reactor core. The experimental facility is automatically

controlled from the project control panel so that it may be temporarily operated without supervision. Any trouble will release a signal and appropriate measures will be initiated by safety circuits. In special cases the H_2 system is evacuated or the reactor is scrammed. The cold neutron source as a whole is designed to allow for a very safe operation. (auth)

7403 EXAMPLE OF THE USE OF LOW-TEMPERATURE GAS SEPARATION FOR NUCLEAR REACTORS. Lehmer, W. Linde AG, Hoellriegelskreuth, Ger.). pp 62-4 of Proceedings of 2nd International Cryogenic Engineering Conference, Brighton, Eng., 7–10 May 1968. Guildford, Eng., Iliffe Science and Technology Publications Ltd., 1968.

See CONF-680505.

The purification of protective gases used in the helium gas system of the test reactor ESSOR of the Euratom Research Centre at Ispra, Italy, is dealt with. Low-temperature process steps such as drying by freezing and gas phase adsorption are discussed. Specific purification requirements for various operating cases are met by one continuously on-stream plant. (auth)

7404 STUDIES ON THE LOW TEMPERATURE AQUEOUS CORROSION OF MILD STEEL UNDER REACTOR RADIATION. PART I. DESIGN, CONSTRUCTION, AND COMMISSIONING OF AN EXPERIMENTAL LOOP IN THE BEPO REACTOR. Crawford, T. S. (Central Electricity Generating Board, Bristol, Eng.); Rowe, M. D.; Hill, S. S.; Whittle, I. J. Brit. Nucl. Energy Soc., 7: 302-6(Oct. 1968).

A loop designed to investigate the aqueous corrosion (particularly crevice corrosion) of mild steel under reactor radiation at 40°C is described. The loop was installed in an experimental hole in the BEPO reactor at Harwell, and the design conditions for the cooling water pipes of prestressed concrete reactor pressure vessels were simulated. Details of specimen preparation, and the design, construction and commissioning of the loop are presented, with particular attention to water quality control. (auth)

Rocket and Space Reactors

Refer also to 6741.

7405 (ANL–7422) HEAT-PIPE-COOLED FAST-REACTOR SPACE POWER SUPPLY. Roberts, J. J.; Croke, E. J.; Carter, R. P.; Norco, J. E. (Argonne National Lab., Ill.). June 1968. Contract W-31-109-eng-38. 35p. Dep. CFSTI.

A fast-spectrum, nuclear-reactor power supply was designed which compares favorably with radioactive isotope sources and SNAP thermal reactors in the 1 to 5 kW(e) range. The use of a ^{239}Pu-based fuel in a relatively simple design, which employs in-core heat pipes and a heat-pipe radiator, yields a comparatively lightweight and low-cost system, which should have good intrinsic reliability. The specific weight for the proposed 1-kW(e) reactor system is about 525 lb/kW(e) (340 lb/kW(e) at 5 kW(e)), as compared to typical weights of about 1000 lb/kW(e) for isotope powered supplies and more than 800 lb/kW(e) for existing SNAP thermal-reactor designs in this power range. Unlike competitive isotopes, ^{239}Pu will be available to meet the anticipated demand for unmanned experimental communication satellites in the 1970's. Moreover, the production cost of this fuel should be approximately 20–70% of the equivalent in isotope power in the 25 to 125 kW(t) power range. (auth)

7406 (NAA-SR-Memo–12611) S8DR FLOW DISTRIBUTOR DESIGN. Tromel, R. H. (Atomics International, Canoga Park, Calif.). Nov. 10, 1967. 17p. Dep. CFSTI.

A flow distributor was designed which meets the objective of uniform pressure in the lower plenum of the S8DR. The distributor fits in the current S8DR vessel. The design technique is similar to that used for designing gas manifolds or some types of heat exchanger headers. Performance tests of the distributor were made using the SNAP 8 hydraulic model and determining the uniformity of the velocity profile within the core. Results showed the profile in lower regions of the core to be flat within ±8%, which is less than the scatter expected due to channel to channel area variation. (auth)

Process Heat and Desalination Reactors

7407 (CONF-680640) SEA WATER CONVERSION STATE OF THE ART CONFERENCE. Proceedings. (Interagency Council for Ocean Resources. California State Senate Water Resources Committee, Sacramento. California State Assembly Water Committee, Sacramento). June 18, 1968. 98p.

Papers on conversion of sea water are given; titles of papers are: "Nuclear Desalting–A Look to the Future"; "Saline Water Conversion Research at the University of California"; "Status and Potential of Desalting for Water Supply"; "The Flash Desalting Process"; "Vertical Tube Evaporators for Large-Capacity Sea Water Desalination"; "Reverse Osmosis"; "Prospects and Application for Large Scale Water Supplies from the Sea"; and "Light Water Reactors." (M.L.S.)

Marine and Portable Power Reactors

7408 INVESTIGATION OF A SCALE MODEL OF THE NERO STEAM GENERATOR. van de Wijngaert, B. H. Atoomenergie Haar Toepass., 10: 199-206(Sept. 1968). (In Dutch).

A description of the 6 MW NERO installation is given; a layout diagram is shown. A 6 MW steam generator for the NERO installation is described; cross sectional diagrams are included. The experimental program for the steam generator is outlined. The preliminary results of measurements are given; data are shown graphically. (M.L.S.)

7409 DESIGN OF A MARINE NUCLEAR POWER PLANT UTILIZING THE DIRECT BRAYTON CYCLE. Gathy, Bruce Stephen. Nav. Eng. J., 79: 887-95(Dec. 1967).

The feasibility of incorporating a reactor power plant in a large passenger ship is examined. The concept studied is a He-cooled water-moderated reactor utilizing the direct Brayton cycle with gas turbines and a waste-heat boiler. The total weight, total space, ship range, overall plant efficiency, and other characteristics of the concept are calculated and compared to those of a conventional power plant. (H.D.R.)

7410 PRESSURE VESSEL FOR A NUCLEAR-POWER SHIP. Yoshida, Toshio (to Hitachi Engineering Co., Ltd.). Japanese Patent 1968-15790. July 2, 1968. Filed Jan. 13, 1965.

By the method proposed, the fuel elements in the vessel can always be below the water level in the vessel, thereby lengthening their life. Several tens of tubes extend into the pressure vessel from the bottom. The fuel elements in the respective tubes are fixed on the support plate through universal joints; the plate is provided with a ring-shaped weight so that the pressure vessel can take its right position with regard to the water level. The plate itself is fixed to the ship hull through its support rod and stand. (NSA of Japan)

7411 SPACE AND MARINE APPLICATIONS. pp 175-213 of Proceedings of the 1967 Conference, Atomic Industrial Forum, Inc., Chicago, November 6–9, 1967. New York, Atomic Industrial Forum, Inc., 1968.

See CONF-671115.

Special applications of compact nuclear power systems are outlined; undersea applications are detailed. The use of ^{238}Pu for space missions is discussed; availability of ^{238}Pu is considered. 15 references. (M.L.S.)

Reactor Theory

Refer also to abstracts 7210, 7216, and 7281.

7412 (BNL–12911) ITERATIVE SOLUTIONS TO REACTOR EQUATIONS. Goldstein, Rubin (Brookhaven National Lab., Upton, N. Y.). Mar. 1967. 10p. (CONF-670501–15). Dep. CFSTI.

From International Conference on Research Reactor Utilization and Reactor Mathematics, Mexico City, Mex.

Recursion formulas for obtaining iterative solutions to reactor kinetics equations are derived. Comparisons of iterative and variational techniques for kinetics equations solutions are discussed. Application of the iterative process to the solution of non-self-adjoint equations of the neutron resonance absorption-type is described. (M.L.S.)

7413 (BNL–12912) TECHNIQUE FOR COMPUTING THE NONLINEAR COUPLING OF SPATIAL MODES. Shotkin, Louis M. (Brookhaven National Lab., Upton, N. Y.). Mar. 1967. 11p. (CONF-670501–16). Dep. CFSTI.

From International Conference on Research Reactor Utilization and Reactor Mathematics, Mexico City, Mex.

Matrix techniques are used for computing the nonlinear coupling of spatial modes in reactor kinetics problems. Matrices are expressed in terms of perturbed flux, Xe, and I_2 concentrations; stability criteria are determined for the system. Assumptions

and approximations are defined for reducing the nonlinear coupled differential equations of the system to sets of linear algebraic equations. An example of a system which is linearly stable, but nonlinearly unstable for large enough perturbations, is included. (11 references) (M.L.S.)

7414 (ORNL-TM-2034(Vol.4)) REACTOR OPERATOR STUDY HANDBOOK (PROGRAMMED INSTRUCTION VERSION). VOLUME IV. HEAT THEORY AND FLUID FLOW. Sheppard, S. D. (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 119p. Dep. CFSTI.

General principles of both heat theory and fluid flow are presented in a programmed text. Principles of greatest benefit to operators of nuclear reactors are discussed in sections on heat, heat transfer, fluid mechanics, and heat production and control in nuclear reactors. Information is presented in small frames, and self-test questions for review are included at the end of each section. (H.D.R.)

7415 (SC-CR-68-3739) MODERN CONTROL ASPECTS OF NUCLEAR REACTORS. Final Report. Phelan, J.; Knudsen, H. K.; Mohler, R. R. (New Mexico Univ., Albuquerque. Bureau of Engineering Research). July 1968. Contracts AT(29-1)-789; 53-6574. 58p. (EE-157). Dep. CFSTI.

Optimal control and the synthesis of practical suboptimal controls for reactors were investigated. A quasi-linear programming algorithm was developed to solve problems involving constraints in state and control by a sequence of linear programming solutions. The system is put into the realm of linear programming problems by a set of difference equations and a linearization procedure. The design of suboptimal controllers was examined by development of the concept of constant quality surfaces in state space. System controllability was investigated by a derivation of the reachable states for a reactivity-constrained two-dimensional system. Controllability of bilinear systems was also examined. A Popov stability analysis was used to extend a frequency response for a linearized reactor control system to include certain time-invariant nonlinearizations such as appear in control actuators. The computation of optimal controls for a nuclear rocket reactor is included in the appendix. (H.D.R.)

7416 (UJV-2072-R) THE AGE-DIFFUSION HETEROGENEOUS KERNEL IN A CYLINDRICAL REACTOR. Miasnikov, A. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Sept. 1968. 6p. Dep.

The slowing-down density in nonabsorbing moderating medium with cylindrical boundary caused by the line source of fast neutrons is calculated. The Fermi's age theory is used. Further, heterogeneous age-diffusion kernel (slowing-down followed by diffusion) based on the previous result is calculated. (auth)

7417 METHOD OF SOLVING DIFFUSION PROBLEMS IN MULTIPLE HETEROGENEOUS REGIONS AND ITS USE IN CALCULATING THE EFFICIENCY OF REGULATING CYLINDERS WITH ABSORBING LAYERS ON THE SURFACES. Mschil'skii, A. P. At. Energ. (USSR), 25: 148-50(Aug. 1968). (In Russian).

It is assumed that N regulating cylinders are placed symmetrically in the reflector of a reactor. The exposed cross section can be represented by N equivalent sectors. For a two-energy group of neutrons with a P_1 approximation a set of equations are derived for the distribution of neutron fluxes along the sector AOB and in the core. The solutions are obtained in the form of rapidly converging regular series so that it is necessary to use only the first 3 or 4 terms in the series in order to calculate the neutron multiplication or neutron flux in this type of reactor. A simple algorithm is available for calculating the trigonometric and Bessel functions on a digital computer. (TTT)

7418 DYNAMIC RESPONSE OF A REACTOR COOLANT CHANNEL DUE TO STEP VARIATIONS OF INLET FLUID TEMPERATURE, POWER GENERATED IN THE FUEL, AND FLUID VELOCITY. Forghieri, Roberto; Papa, Giorgio (CNEN, Bologna). Nucl. Eng. Design, 8: 191-200(1968).

The dynamic response of a coolant channel due to sharp variations of inlet temperature, power generated within the fuel and fluid velocity is examined. The radially lumped model and the distributed parameter model are carefully analysed and the analogy of the solutions is shown. The analytical results are obtained using both Laplace and finite Hankel transformation techniques. (5 references) (auth)

7419 SYNTHESIS TECHNIQUE FOR VARIABLE SURFACE HEAT TRANSFER. Holy, Z. J. (Univ. of New South Wales, Kensington, Australia). Nucl. Eng. Design, 8: 289-98(1968).

A synthesis technique based on a variational approach is developed for solution of temperature fields due to non-uniform heat transfer distribution over the surface of a heat producing body. The method is applied to an infinite half-space and a sphere with axisymmetric distribution for which simple analytical results are derived using only two trial functions in the synthesis. Possible means of selecting these trial functions are discussed. A number of heat transfer distributions are analysed; the results are compared with known solutions and conclusions are drawn as to the accuracy and applicability of the method. (4 references) (auth)

7420 CORE COOLING IN A HYPOTHETICAL LOSS OF COOLANT ACCIDENT. ESTIMATE OF HEAT TRANSFER IN CORE MELTDOWN. Tong, L. S. (Westinghouse Electric Corp., Pittsburgh). Nucl. Eng. Design, 8: 309-12(1968).

A preliminary estimate of heat transfer in the asymptotic configuration of a meltdown core was conducted. The result indicates that a complete core meltdown will not melt through the bottom of the reactor vessel. Items for further studies are also mentioned. (5 references) (auth)

7421 HEAT TRANSFER FOR SLUG FLOW IN TRIANGULAR CHANNELS AND IN REGULAR POLYGONAL CHANNELS. Friedland, Aaron J. (Atomic Power Development Associates, Inc., Detroit). Nucl. Eng. Design, 8: 299-308(1968).

It is shown that the normalized temperature distribution for slug flow in all regular polygonal channels with uniform heat flux at the walls is identical with that for slug flow in all triangular channels with any combination of uniform heat fluxes on the three walls. Therefore, the known solution for a circular or for a square channel can be used to determine the temperature distributions for all the other cases. Slug flow Nusselt numbers and maximum wall temperatures are presented for triangular channels with uniform wall heat flux, and an equation is given for the Nusselt number for polygonal channels. (auth)

7422 APPLICATION OF NEUTRON WAVE EXPERIMENT TO HYDROGENOUS SYSTEMS. Utsuro, Masahiko (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo), 5: 599-600(Nov. 1968).

A method for using neutron wave experiments for hydrogenous systems is described. The method is based on the proportionality of the Boltzmann transport equation. (D.C.C.)

7423 STUDY OF NEUTRON WAVE PROPAGATION. Hayasaka, Hideo; Takeda, Seiiti (Tohoku Univ., Sendai). J. Nucl. Sci. Technol. (Tokyo), 5: 564-71(Nov. 1968).

Neutron wave propagation in both non-multiplying and multiplying media is treated on the basis of the monochromatic telegrapher's equation. This approach makes it possible to take account of the aspects related to wave characteristics. Using the Green function of the telegrapher's equation, the transient behavior of neutron waves propagating in a finite homogeneous medium is investigated. It is found that wave propagates in three different ways depending upon the size and nuclear properties of the medium. The asymptotic solutions of the telegrapher's equation are next investigated. The dispersion relations of non-multiplying and multiplying media are derived. 6 references. (auth)

Experimental Applications

7424 (IDO-17276) PHYSICS METHODS USED TO COMPUTE REACTIVITY, $\Lambda/\bar{\beta}_{eff}$, AND ROD WORTH FOR THE PBF CRICITAL EXPERIMENTS. Rushton, B. L. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Oct. 1968. Contract AT(10-1)-205.. 71p. Dep. CFSTI.

Unusual characteristics of the Power Burst Facility (PBF) that add to the complexity of physics calculations have been mocked up in critical experiments and furnish a means of testing the accuracy of the calculational methods and of the basic cross section data used in the physics design. The techniques used to calculate reactivity, control rod worth, and $\Lambda/\bar{\beta}_{eff}$ for the critical configurations gave generally good results. The results indicate that the calculational techniques should be adequate for PBF design purposes. The calculational techniques and the experimental apparatus are described and comparisons of measurements with calculations are given. (16 references) (auth)

7425 CAVITATION NOISE IN NUCLEAR REACTORS. Saxe, R. F. (North Carolina State Univ., Raleigh); Lau, L. W. Nucl. Eng. Design, 8: 229-40(1968).

An experimental investigation was made of the acoustical noise emitted by flow-induced cavitation in reactor fuel element coolant channels. Spectra of the acoustical noise emitted are shown and are correlated with optical measurements taken by means of short-exposure photographs. It is shown that the amount of acoustical noise emitted by cavitation increases very rapidly with increase of flow rate and is approximately proportional to the number of cavitation bubbles present. In addition,

it is deduced that the spectrum of the acoustical noise emitted by cavitation is approximately flat up to frequencies in excess of those measured and that peaks in the recorded spectra were due to microphone characteristics. 11 references. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 6270, 6326, 6330, 6331, 6630, 6644, 6650–6652, 6663, 6666, 6667, 6715, 6717, 6719, and 6764.

7426 (DOCKET-50332–1) BARNWELL NUCLEAR FUEL PLANT. Safety Analysis Report, Vol. 1. (Allied Chemical Nuclear Products, Inc., Morristown, N. J.). Nov. 7, 1968. 375p. Dep. CFSTI.

Information on Barnwell Nuclear Fuel Processing Plant is given under the following broad topics: General Considerations; Design Criteria; Process Systems; Auxiliary Systems; Confinement Systems; Radiological Protection; Management Systems; Pre-operational Testing; Site Description; Safety Analysis; and Technical Specifications. (D.C.C.)

7427 (DOCKET-50332–2) BARNWELL NUCLEAR FUEL PLANT. Safety Analysis Report, Vol. 2. (Allied Chemical Nuclear Products, Inc., Morristown, N. J.). Nov. 7, 1968. 450p. Dep. CFSTI.

Appendices included contain information on: fuel fission product contents, criticality control and nuclear safety, site studies, soils investigation, geophysical study, consultants' reports, design bases, meteorological study, effluents, and background radiation. (D.C.C.)

7428 (DOCKET-50332–3) [BARNWELL NUCLEAR FUEL PLANT]. LICENSE APPLICATION. (Allied Chemical Nuclear Products, Inc., Morristown, N. J.). Nov. 6, 1968. 35p. Dep. CFSTI.

Financial data on the owner of the Barnwell Nuclear Fuel Processing Plant are given in support of the application for operating license. The 1967 Annual Report for the Allied Chemical Corporation is included. (D.C.C.)

7429 (EURAEC–2065) USE OF PLUTONIUM AS A FUEL IN NUCLEAR REACTORS. Quarterly Report No. 18, April 1–June 30, 1968. Bairiot, H.; Lhost, A.; Deramaix, P. (comps.) (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium). Societe Belge pour l'Industrie Nucleaire, Brussels). Aug. 1968. Contract 001-64-1-TRUB. 87p. (EUR–4001). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

Topics discussed include: fabrication of PuO_2-UO_2 fuel rods by vibratory compaction; assaying Cl by spectrophotometry; and neutron radiation effects on Zircaloy 2-clad and Type 304 stainless steel-clad rods of PuO_2-UO_2. (D.C.C.)

7430 CROSS-CONDUCTION ERRORS IN THERMOCOUPLES. CORRECTION OF LONG SWAGED THERMOCOUPLES AT HIGH TEMPERATURES. Larrain, J.; Bonilla, C. F. (Columbia Univ., New York). Nucl. Eng. Design, 8: 251-72(1968).

The error due to leakage current flowing through the electrical insulation between the wires of a thermocouple is calculated. The error is due to IR drop along the thermocouple wires, and increases rapidly with temperature and length, and with closeness of contact between the wires and solid insulation. Thus, temperature measurements by swaged sheath thermocouples in large, high-temperature, liquid-metal and gas-cooled nuclear reactors and heat transfer loops are particularly susceptible. Charts giving the error in the temperature measurements are presented for step and ramp temperature distributions along unsheathed thermocouples, and along sheathed thermocouples with either a grounded or an ungrounded hot junction. Calculation of the correction is illustrated by a typical installation. (12 references) (auth)

7431 FUEL-ROD SUPPORT MECHANISM. Kanbara, Toyozo (to Hitachi Ltd.). Japanese Patent 1968-17999. July 25, 1968. Filed Sept. 2, 1964.

By the method proposed, stagnant water on the support grid can be made to flow, thereby preventing corrosion. Excessive activation of the water is also prevented. To form the passage for stagnant water, a groove is cut at the joint of the fuel rod and the support grid on either or both sides of the two. (NSA of Japan)

7432 FUEL-ROD SUPPORT MECHANISM. Suzuki, Masanori (to Hitachi Ltd.). Japanese Patent 1968-17998. July 25, 1968. Filed Sept. 10, 1963.

The advantages to the proposed method are the following: easy welding, absorption of the thermal expansion, and containment of the dissociation evolved gases. The fuel rod is supported in the reactor core both at the top and the bottom. To either end of a fuel rod is connected a flexible tube, which is closed at the other end by a plug; the dissociation gas evolved is contained in this space. The fuel rod itself is supported in the reactor core by means of the plugs. (NSA of Japan)

7433 FUEL ROD USING LIQUID FUEL. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1968-17357. July 22, 1968. Filed Nov. 16, 1964.

By the method proposed, the nuclear fuel can be burned efficiently, also improving its thermal characteristic; furthermore, the reactor operation safety can be increased. It contains essentially an inert gas and a liquid fuel in the sealed cladding. To achieve the natural convection of liquid fuel within the cladding tube, a cylindrical body is installed in the tube itself. (NSA of Japan)

7434 URANIUM SITUATION. pp 1-44 of Proceedings of the 1967 Conference, Atomic Industrial Forum, Inc., Chicago, November 6–9, 1967. New York, Atomic Industrial Forum, Inc., 1968.

See CONF-671115.

The uranium supply policies of the U. S. Atomic Energy Commission and the procedures for their implementation are presented. Low cost U reserves are compared with the forecast cumulative demand through 1980. Views of the U producer and the U user regarding the present status and the near term future of the industry are discussed. (H.D.R.)

7435 LONGITUDINAL HYDRAULIC WAVE PHENOMENA IN FUEL ASSEMBLIES CONSISTING OF CONCENTRIC FUEL ELEMENTS. Wick, Robert S. (Texas A and M Univ., College Station). Nucl. Sci. Eng., 35: 118-26(Jan. 1969).

Water-hammer theory is extended to the fuel assembly configuration of concentric annular fuel elements and flow passages. The analysis shows that owing to the coupling of the hydraulic effects in adjacent coolant passages to each other through an elastic structure separating them, several modes of pressure wave propagation are possible. These compression (and rarefaction) waves travel at velocities less than the velocity of sound in the fluid depending on the dimensions of the fuel elements and flow passages. The existence of these compression and rarefaction waves traveling at different velocities leads to complex pressure disturbance patterns as a function of time, which may be of importance in fatigue analysis of the structure or possibly in determining whether or not voids could form as a result of the rarefaction waves. The analysis is general enough that it can be extended to include a wide variety of configurations when it is desirous to evaluate the effect of hydraulic pressure waves on fuel element performance. (auth)

GENERAL

7436 (ACRH–1000–75) CHROMOSOMES IN THE MYELODYSPLASIAS. Rowley, Janet D. (Argonne Cancer Research Hospital, Chicago, Ill. Chicago Univ., Ill. Dept. of Medicine). May 19, 1968. Contract AT(11-1)-69. 13p. (CONF-680529–1). Dep. CFSTI.

From Symposium on Myeloproliferative Disorders of Animals and Man, Richland, Wash.

The possible relationship of chromosomal aberrations in bone marrow cells to leukemia was studied in 64 patients with various hematological disorders. No cases of leukemia occurred during the period. Ten of the patients had major chromosomal abnormalities in 25 to 95% of their mitotic marrow cells. Twenty-three additional patients had a small, variable proportion of chromosome abnormalities. The case histories and results of chromosome studies on three patients are discussed in detail. (C.H.)

7437 (BNWL–901) CONFORMAL MAPPING OF A CIRCLE ONTO A RECTANGLE. Schubert, A. B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1968. Contract AT(45-1)-1830. 45p. Dep. CFSTI.

The problem of mapping the closed unit circle onto the closed rectangle, to study the physics of the coupling of adjacent rectangular reactor cells, is discussed. The analysis of the problem is accompanied by a digital computer program which numerically performs the mapping within specified tolerance on a grid of interior points of the circle and the rectangle. (auth)

7438 (NYO–3661-17) SCHRODINGER EQUATION SOLUTION PROGRAMS. SUBROUTINES SJTRF, GFCN. Miller, Harry; Tao, S. J. (New England Inst. for Medical Research, Ridgefield, Conn.). Jan. 1968. Contract AT(30-1)-3661. 25p. Dep. CFSTI.

The subroutines SJTRF and GFCN for a computer program which calculates the fraction of wave functions outside a spherical well with various boundary conditions are described. (B.G.D.)

7439 (ORO–2503-10) STRUCTURAL STUDIES OF METAL COORDINATION COMPOUNDS. Progress Report, March 1, 1967–October 1, 1968. Quagliano, James V. (Florida State Univ., Tallahassee. Dept. of Chemistry). Nov. 26, 1968. Contract AT(40-1)-2503. 11p. Dep. CFSTI.

Systematic investigations were made of the donor properties of cation ligands formed by monoquaternization of 1,4-diazabicyclo-[2.2.2.]octane (Dabco). Protonated Dabconium cations react with halides of divalent transition metals, Mn through Zn, to form high-spin, four-coordinate complex species having a pseudo-tetrahedral stereochemistry with C_{3v} symmetry. The reactions of divalent nickel halides with various organic cations are being studied. (M.C.G.)